Iron and Steel ENGINEER

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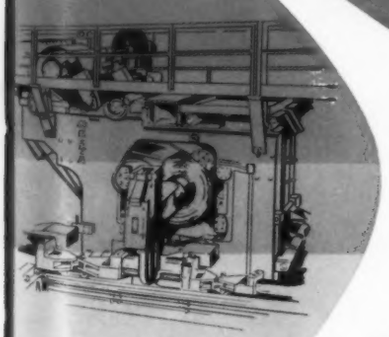

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MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

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FASTER ... EASIER ... SAFER

This ALLIANCE 75-TON straight line type Manipulator manipulates 75-Ton ingots for forging operations. This giant machine operates smoothly and safely. The operator is located in an enclosed cab and has excellent visibility for controlling this powerful manipulator.

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Bits- 68 inch square maximum
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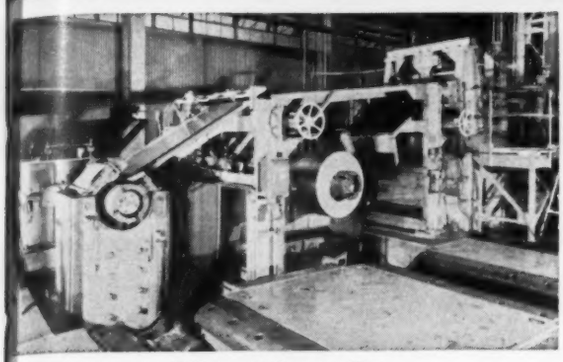
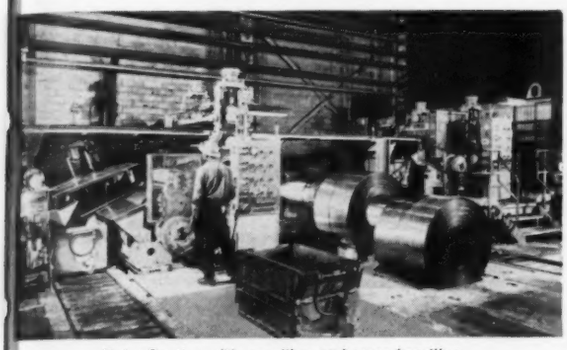
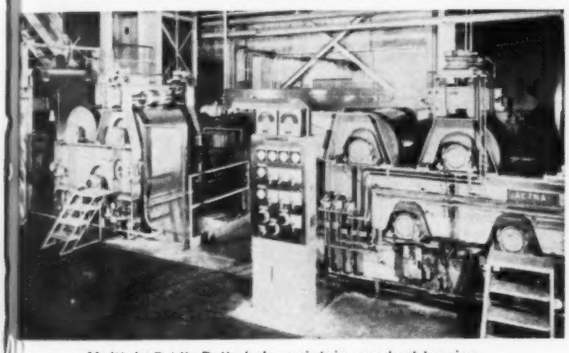
Continuous Annealing and Surface Treatment Lines have a lot in common



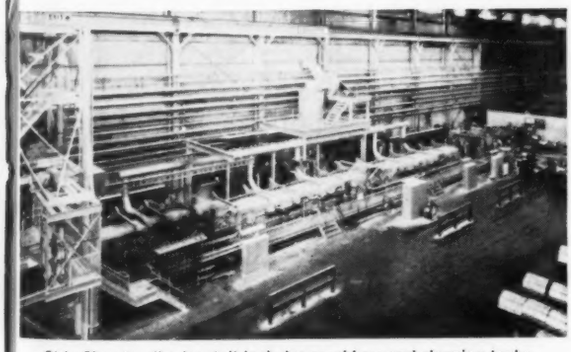
Delivery end shows recoiling.



Entry Section with uncoiling and scrap handling.



Multiple Bridle Rolls help maintain constant tension.



Strip Cleaning (horizontal) includes scrubbers and cleaning tanks.

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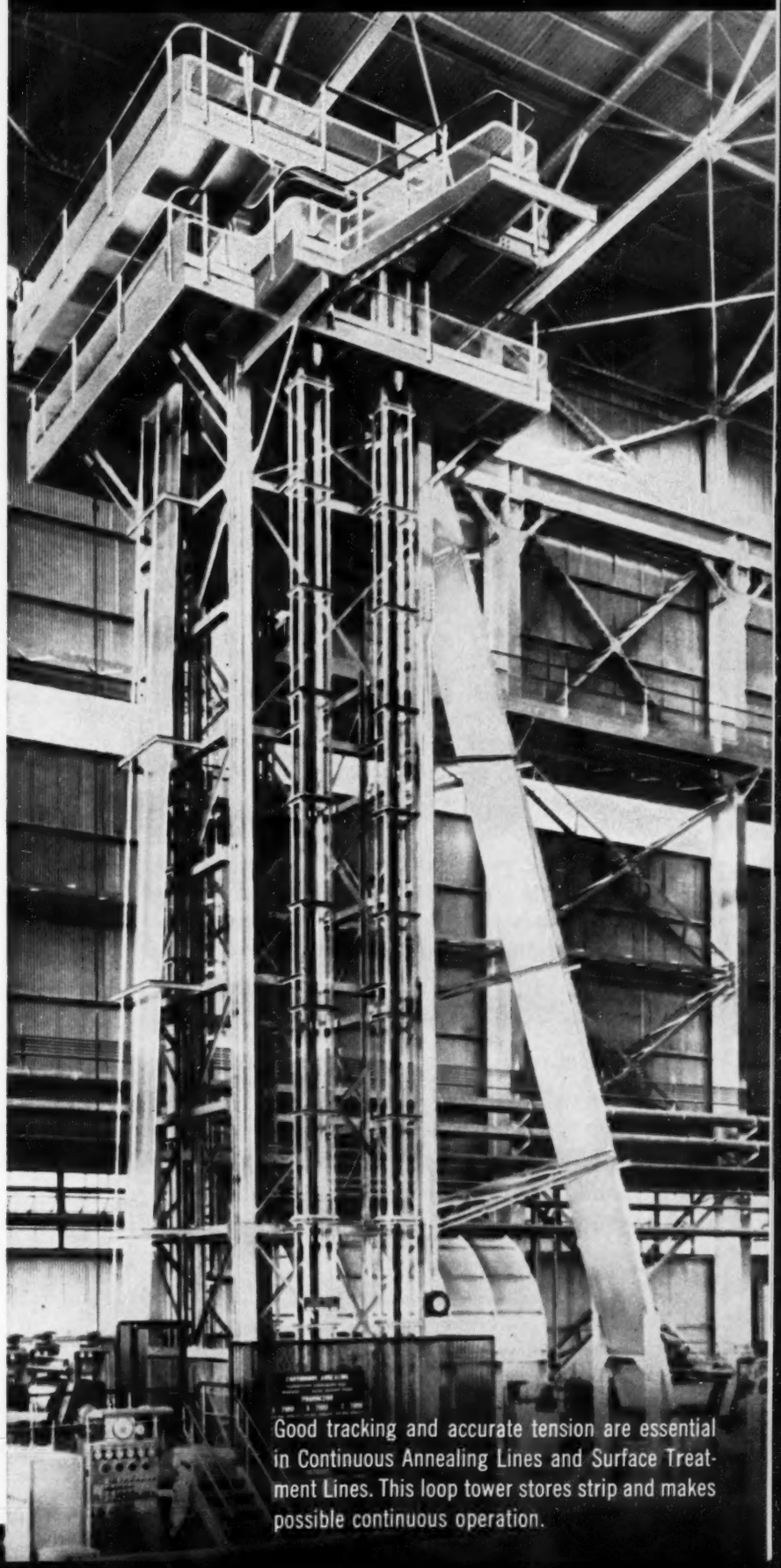
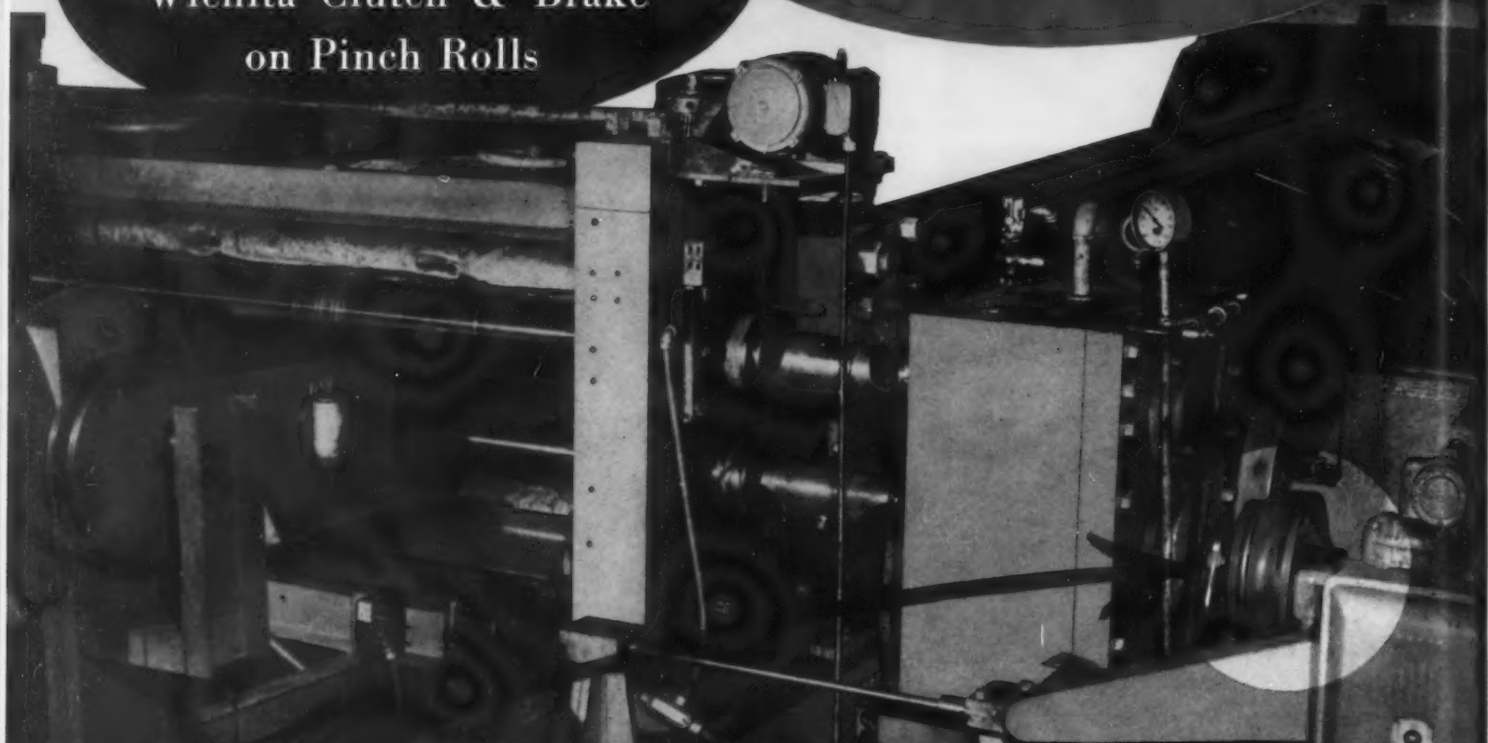


Good tracking and accurate tension are essential in Continuous Annealing Lines and Surface Treatment Lines. This loop tower stores strip and makes possible continuous operation.

Kaiser Aluminum *uses* Wichita Clutch & Brake on Pinch Rolls

...for added feed control in cutting long aluminum strip into any required length



"Functioning very satisfactorily." . . . Kaiser Aluminum, in Spokane, found the addition of Wichita Clutch and Brake improved control on the pinch rolls feeding the shear.

The pinch rolls, top and bottom, feed a long aluminum strip into the shear. Due to the relative speeds between the pinch rolls and the shear blades, they can cut this long aluminum strip into any length required. The shear and pinch rolls are geared together. In order to have more control over minimizing the head end cut, the Wichita clutch was installed on the drive to the pinch rolls. This enables them to stop the pinch rolls with the strip inserted between rolls and to time the head end of the strip into the shear to minimize head end cut.

The tougher the clutching and braking problem is, the better Wichita engineers like it. That's because in many instances Wichita equipment gives outstanding performance under adverse operating conditions . . . and thus proves superiority more convincingly.

For difficult clutching and braking problems . . .

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WICHITA FALLS, TEXAS, U. S. A.

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Published Monthy by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds).....$ 7.50 per year
Subscription price in foreign countries (U. S. funds)..... $10.00 per year

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Second-class mail privileges authorized at Easton, Pa. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122

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OPERATING IN CANADA

56-inch 4-High Cold Reversing Mill at Dominion Foundries and Steel Limited, Hamilton, Ontario, which is equipped with the Davy-United system of Automatic Gauge Control. This mill rolls steel strip for tin plate between 24 inches and 50 inches wide in a range of thicknesses from .006 inches to .050 inches.

Six Automatic Gauge Control installations have now been completed or ordered in North America and Licensees in North America for the Davy-United system of Automatic Gauge Control include General Electric Company of the U.S.A., Canadian General Electric Company Limited and Canadian Westinghouse Limited.

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Photo by Arnold Newman

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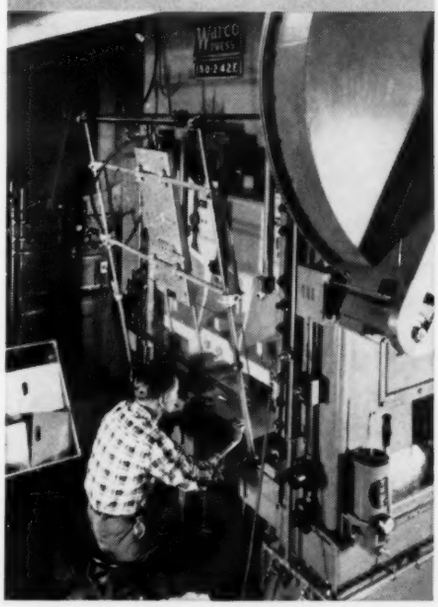
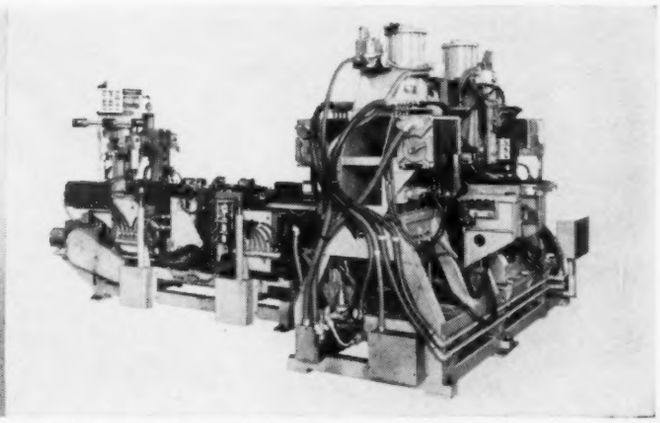
If you fabricate metals and are caught in the "profit squeeze" you'll want to know more about McKay Machine.

It was McKay Machine that pioneered automated integrated production lines, and it is McKay Machine that is today a leader in this field. We have conceived and produced complete lines for the manufacture of building panels, aircraft and missile sections, appliances, cabinets and components, automotive bodies and parts, and farm equipment—lines that are completely automated from *raw material to finished part or product.*

Whatever you make, if it requires metal handling, feeding, slitting, shearing, stamping, welding or forming, it's just good business to acquaint yourself with *McKay Packaged Production Lines*—high speed production equipment engineered to work in unison—with one-source responsibility from start to finish. Write for literature to *The McKay Machine Company, Youngstown 1, Ohio.*

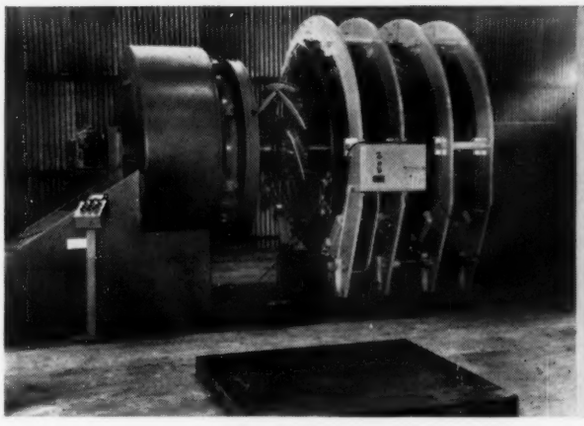
WARCO MECHANICAL PRESSES—advanced in design, noted for their craftsmanship — are used throughout industry. Typical is the high speed, low maintenance 150-ton straight side crank press pictured here in operation at Eastman Kodak.





FEDERAL RESISTANCE WELDERS AND WELDING LINES, like this multi-gun combination spot and projection welder used by Hotpoint on their range production line, can be found in the plants of leading metalworking firms the nation over. Individual units, or complete resistance welding lines, are engineered to specifications by McKay's Federal-Warco Division.

LOOK TO McKAY MACHINE



BERKELEY-DAVIS AUTOMATIC ARC WELDING MACHINERY produced by Berkeley-Davis, Inc., a subsidiary, is highly popular in the aircraft, rocket, automotive and appliance industries. The rocket body welder pictured here is working at Aerojet General, subsidiary of General Tire and Rubber Company.

OPEN UP: for stronger tin plate

Today tin plate is made from several grades of steel, dependent upon final use. By controlling carbon and nitrogen content through the Lee Wilson Open Coil Gas Alloying Process, it is now possible to make many grades of tin plate from one grade of steel. By removing carbon, softer tin plate is possible; by adding nitrogen, harder tin plate is produced. Exacting composition and temper requirements can be achieved and inventory reduced to a minimum. For further details, write to *Lee Wilson Engineering Co., Inc., 20005 Lake Road, Cleveland 16, Ohio.*

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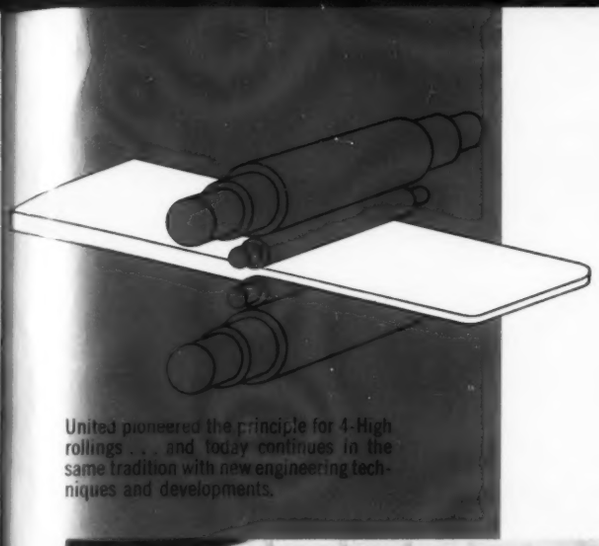

United pioneered the principle for 4-High rollings . . . and today continues in the same tradition with new engineering techniques and developments.

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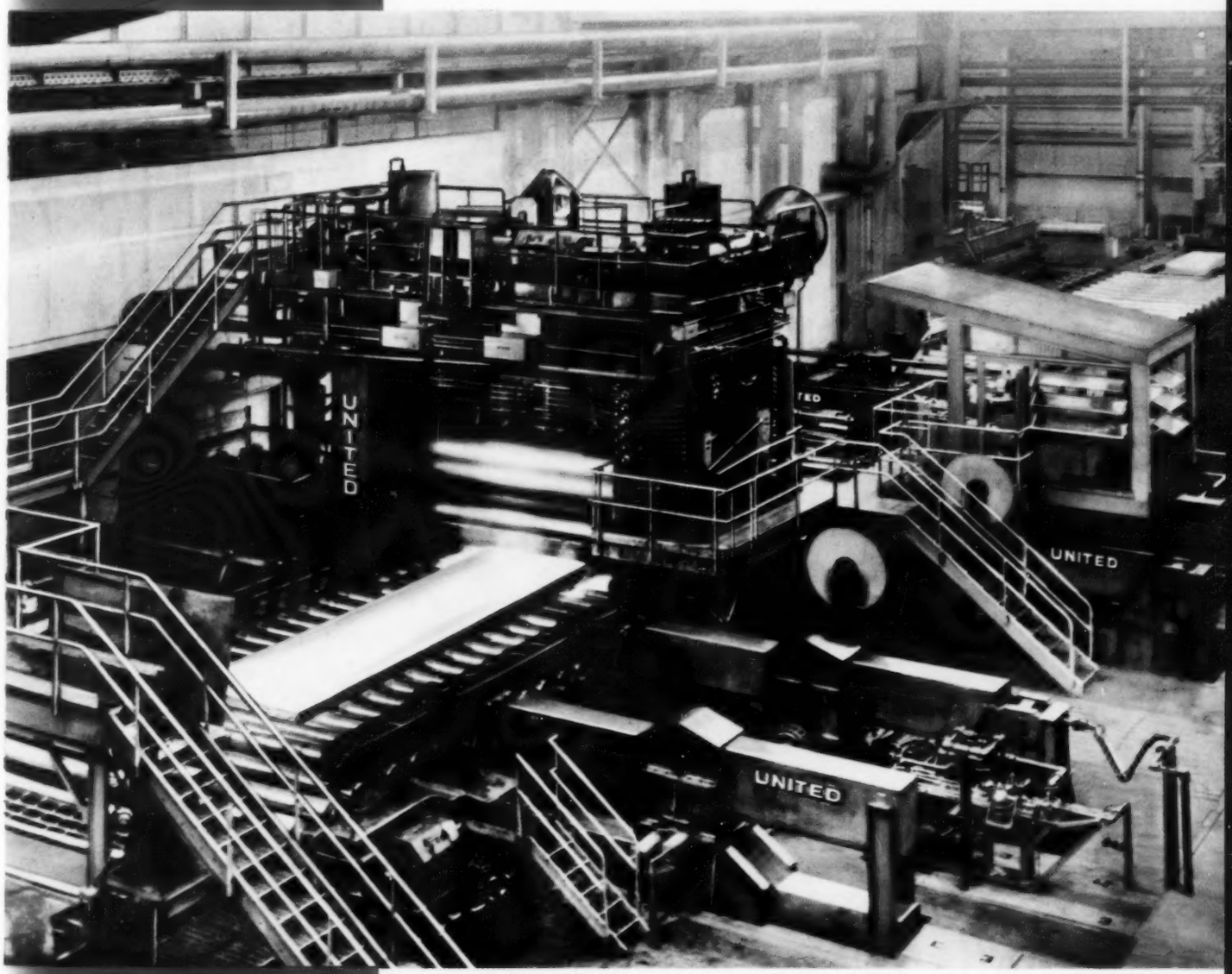
170" 4-HIGH REVERSING

HOT MILL

FOR ROLLING ALUMINUM



This is the world's largest mill of this type for rolling aluminum and is in operation at the Reynolds Metals Company Alloys Plant, Sheffield, Alabama.

Plants at Pittsburgh, Vandergrift, Youngstown, Canton, Wilmington

SUBSIDIARIES: Adamson United Company, Akron, Ohio; Stedman Foundry and Machine Co., Inc., Aurora, Indiana

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△ Steel orders are rekindling the spark in steelmakers' eyes. U. S. Steel chairman Roger Blough thinks February was the low point. C. G. Tournay, president of Weirton Steel Co., sees each month showing improvement for the first half of the year. Avery C. Adams, chairman of Jones & Laughlin, is convinced that each successive quarter during the rest of the year will show increased business and the industry will make 118,000,000 tons of ingots in the 12 months beginning July 1. Republic president Thomas F. Patton says the recovery of general business activity is turning out to be more vigorous than most people anticipated. He believes ingot production from mid-1961 to mid-1962 will total 117,000,000 tons. Industry leaders, in general, expect 1961 production to approximate 100,000,000 tons.

△ Diverging opinions marked the discussions at the recent meeting of the American Iron and Steel Institute. Arthur F. Burns, president of the National Bureau of Economic Research, urged support of President Kennedy's recommendation to revise provisions of our tax laws which encourage the flow of American capital to tax havens abroad. Logan T. Johnston, president of Armco Steel Corp., favors greater international operations. Mr. Johnston quoted Department of Commerce figures showing that $12,000,000,000 was sent overseas for plants and equipment between 1950 and 1960, but over $20,000,000,000 was returned in the same period in dividends, interest, etc.

△ By 1965 the steel industry of the United Kingdom will have 32,000,000 tons of "reasonably" modern, effective ingot capacity, which the Iron and Steel Board estimates will be sufficient to meet forseeable domestic demand and leave a margin for export. Of this, 66 per cent will be open hearth capacity, 12 per cent electric furnace capacity and 21 per cent in bessemer and oxygen processes.

△ The following "Lament of a Staff Man" seems to fit a lot of jobs:

I'm not allowed to run the train
or see how fast t'will go.
I ain't allowed to let off steam
or make the whistle blow.
I cannot exercise control
or even ring the bell,
But let the damn thing jump the track
and see who catches hell.

△ Italian steel production has grown by 135 per cent since 1953. Annual capacity is now about 9,200,000 net tons. Over half of Italian production is by the open hearth process and 38 per cent by the electric furnace. The proportion of flat-rolled products has been greatly increased and now represents 44.5 per cent of the total.

△ Nothing ruins a neighborhood for the average husband like having an enthusiastic gardener move in.

△ Perhaps never before have the steel companies been so aggressive in defending their markets and promoting their products. Alerted, if not alarmed, by the inroads of nonferrous metals, plastics and other materials, the steel industry is emphasizing the advantages of steel and the strides that have been made in improving steel. Great Lakes Steel Corp. recently featured a series of steel-vs-aluminum bumper test demonstrations to prove the superiority of steel in this application. United States Steel Corp. held a design and engineering seminar on new ways to use modern steels. U. S. Steel has also brought out quenched and tempered alloy steels in structural shapes. Much of steel industry research is directed to the development of new products, improved products and expanded application of these products. As Roger M. Blough said, steel is rolling up its sleeves.

△ Someone claims that Cuba is the biggest country in the world, with its capital in Havana, its government in Russia and most of its people in the United States.

△ For the sixth time in ten years, the steel producing divisions of United States Steel Corp. received the National Safety Council's Award of Honor with an all-time low frequency rate of 0.79 lost-time accidents per million man-hours worked. Contributing to this showing was Gary Steel Works' record of 17,133,243 man-hours without a lost-time accident.

△ It isn't really true that JFK means Jobs For Kinfolk.

△ United Steelworkers president David J. McDonald complains that the industry now needs only 450,000 production workers to make 105,000,000 tons of ingots, whereas it took 567,800 workers to do it ten years ago. Assuming these figures to be correct, if we apply the respective hourly employment costs of $3.82 in 1960 and $1.91 in 1950 to these labor forces, we find that total labor cost per ton of steel is now 59 per cent above 1950.

△ A man supporting two wives is not necessarily a bigamist. He may have a son who is married.

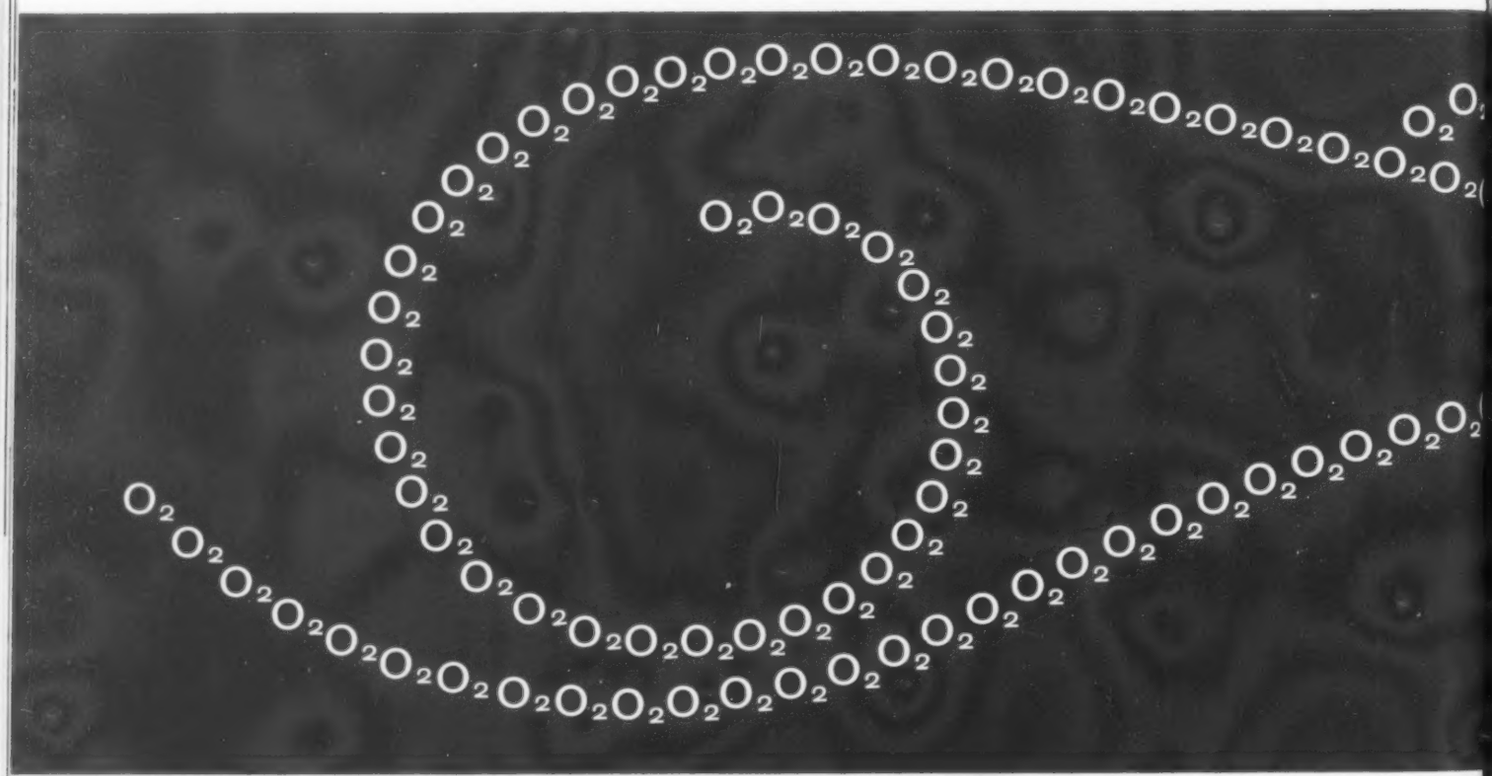
△ Steel producers see a bad cost-price squeeze coming in October, with increased pressure for price boosts.

△ According to Charles J. Potter, president of Rochester & Pittsburgh Coal Co., U. S. coal consumption will begin to rise by the end of 1961 and will climb to an annual rate of 479,000,000 tons by 1975, 20 per cent above 1960 consumption.

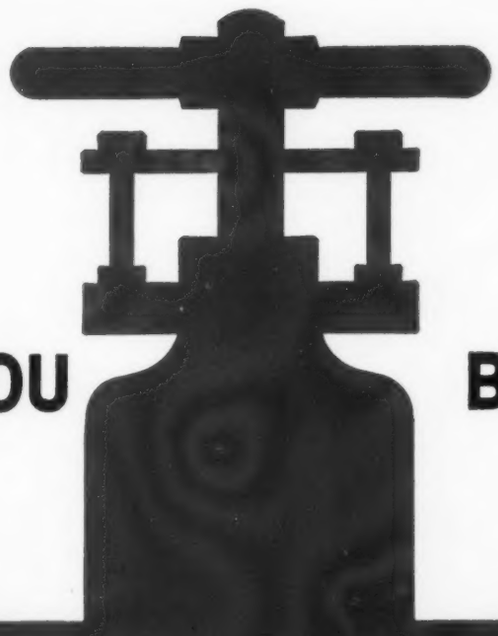
△ Psychiatrists say it's not good for a man to keep too much to himself. The Department of Internal Revenue says the same thing.

O_2

OXYGEN FOR STEEL IS <u>ALWAYS</u> ON TAP WHEN



Your oxygen supply, piped from a plant we build and operate, on or adjacent to your site, is backed by 45 years of experience in air separation. We have the resources and sound engineering ability to keep your



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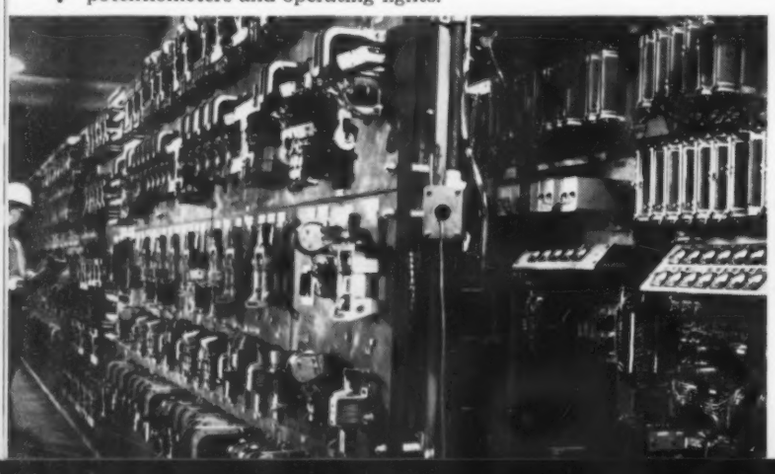
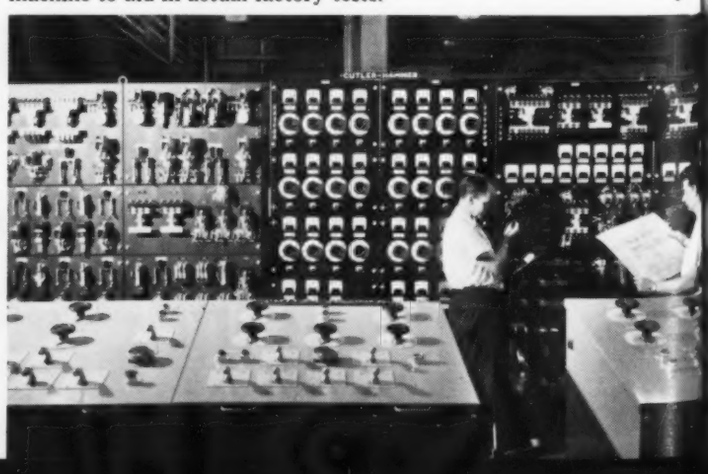
Cutler-Hammer Control. Shown here, the control of 87 D.C. motors, employing 16 static regulators. Kaiser annealing line control system also regulates 45 A.C. auxiliary motors; requires 10 operators' stations and more than 300 meters, pushbuttons, master switches, potentiometers and operating lights.



Cutler-Hammer Test Floor. Here, complete factory tests of systems control prior to shipment insure faster installation, more trouble-free start-ups. Analog computer-simulator can test engineering solutions before construction; simulate response of any motor or machine to aid in actual factory tests.



What's new in systems control?

Cutler-Hammer Control commands 1600 h.p. High Speed Annealing line at Kaiser Fontana

Big D-c system meets demanding requirements on 1200-FPM line

The responsibility for making the block-long system of huge equipment in a modern annealing line function continuously and in perfect step falls on control engineering. For this responsibility, including all control and rotating equipment, Kaiser selected Cutler-Hammer in the recent expansion of its Fontana works.

The problem: a continuous flow of steel strip through entry, furnace and recoil sections . . . through looping towers on each side of the furnace . . . at 1200 to 1500 FPM!

Laboratory testing speeds trouble-free start-up

Each step posed a critical control problem. Yet Cutler-Hammer's systems and control engineers bound the whole into a smoothly operating team. The entire system was pre-tested in Cutler-Hammer laboratories. Result: Kaiser-Fontana reaped the benefits of a more complete test, quicker installation, and a faster, more trouble-free start-up. Kaiser today produces the uniform quality tinplate demanded by its customers.

Cutler-Hammer control systems and equipment were installed on seven of the first nine high-speed annealing lines built. Cutler-Hammer engineering and equipment is also at work on the Fontana pickling line, coil preparation line, and in auxiliaries for slabbing, hot strip and temper mills.

Call the C-H man . . . early!

Cutler-Hammer's broad experience in all phases of systems control design means the Cutler-Hammer man brings a knowledgeable eye to your particular control problem. Cutler-Hammer procedures insure a complete pre-test of your system. Assure you a quicker installation and a faster, trouble-free start-up. Call your nearby Cutler-Hammer office early.

WHAT'S NEW? **ASK...**

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Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

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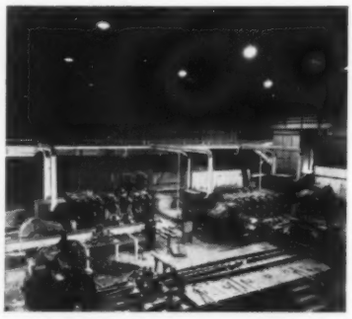
VITAL VALUES

Air that's pure—really pure—is vital to the operation of steel mill drive motors. And ultimate purity of the filtered air is one of the Vital Values you get with Wheelabrator Air Filters. At a prominent steel mill, installation of Wheelabrator Ultra-Filtration to provide clean air to three drive motors totaling 2,200 h.p. has virtually eliminated weekly motor maintenance attention, saving $3,120.00 in direct labor cost alone per year. Added to this saving, mill room down time costing $6,000.00 annually due to motor trouble has been avoided. Wheelabrator Ultra-Filtration provides the air purity required, at a cost far lower than many systems offering less efficiency. Get the whole story of these vital savings. Write today for information.



In this mill room, a Wheelabrator Ultra-Filtration® unit has eliminated the cost of 24 man-hours of maintenance labor a week in upkeep of 3 roughing mill drive motors.

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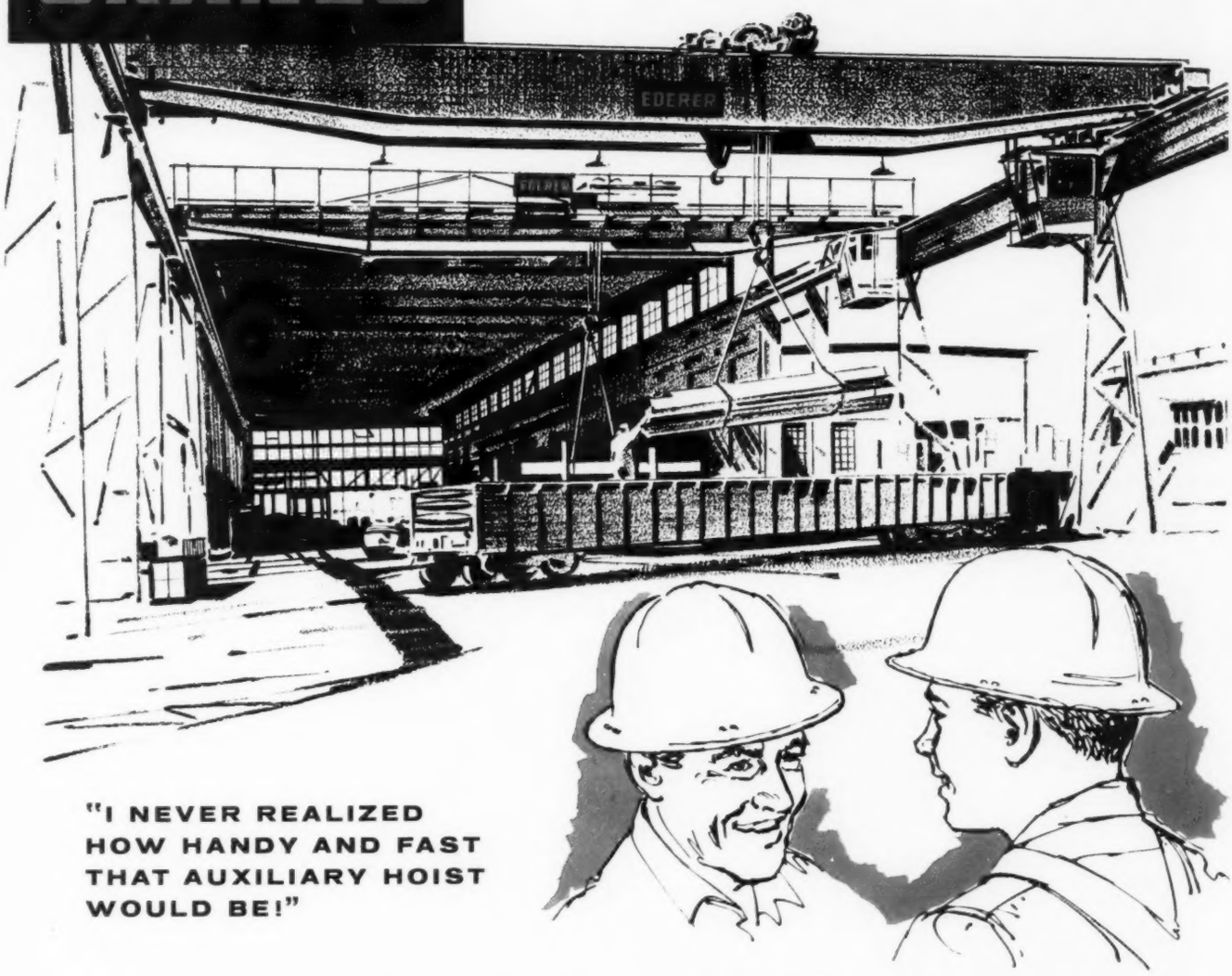

"I NEVER REALIZED HOW HANDY AND FAST THAT AUXILIARY HOIST WOULD BE!"

It's sort of like sending a man to do a boy's work . . . in many cases . . . to use the main hoist on a crane to handle light loads. In many industrial plants, where a great variety of loads are being handled all the time, an auxiliary hoist handles light loads more rapidly and with less power consumption.

This factor is taken into account when EDERER "job-engineers" a crane for a plant where this flexibility is important. This is typical of EDERER "job engineering" for the materials handling requirements of all types of plants in the metals industries. Perhaps an EDERER engineer can help in such planning for your requirements.

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SINCE 1901 "JOB-ENGINEERING" CRANES AND HEAVY EQUIPMENT

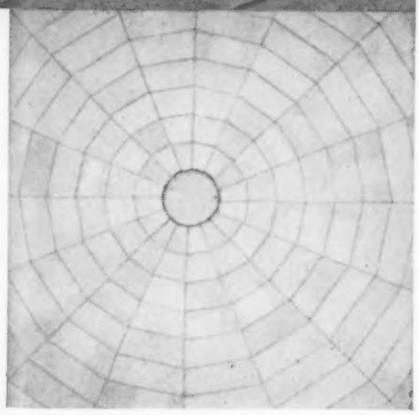
Bell-type annealing furnaces hold critical temperatures better—using J-M Superex

LEE WILSON ENGINEERING COMPANY, INC., STANDARDIZES ON J-M SUPEREX BLOCK INSULATION FOR PRECISION AND PERFORMANCE

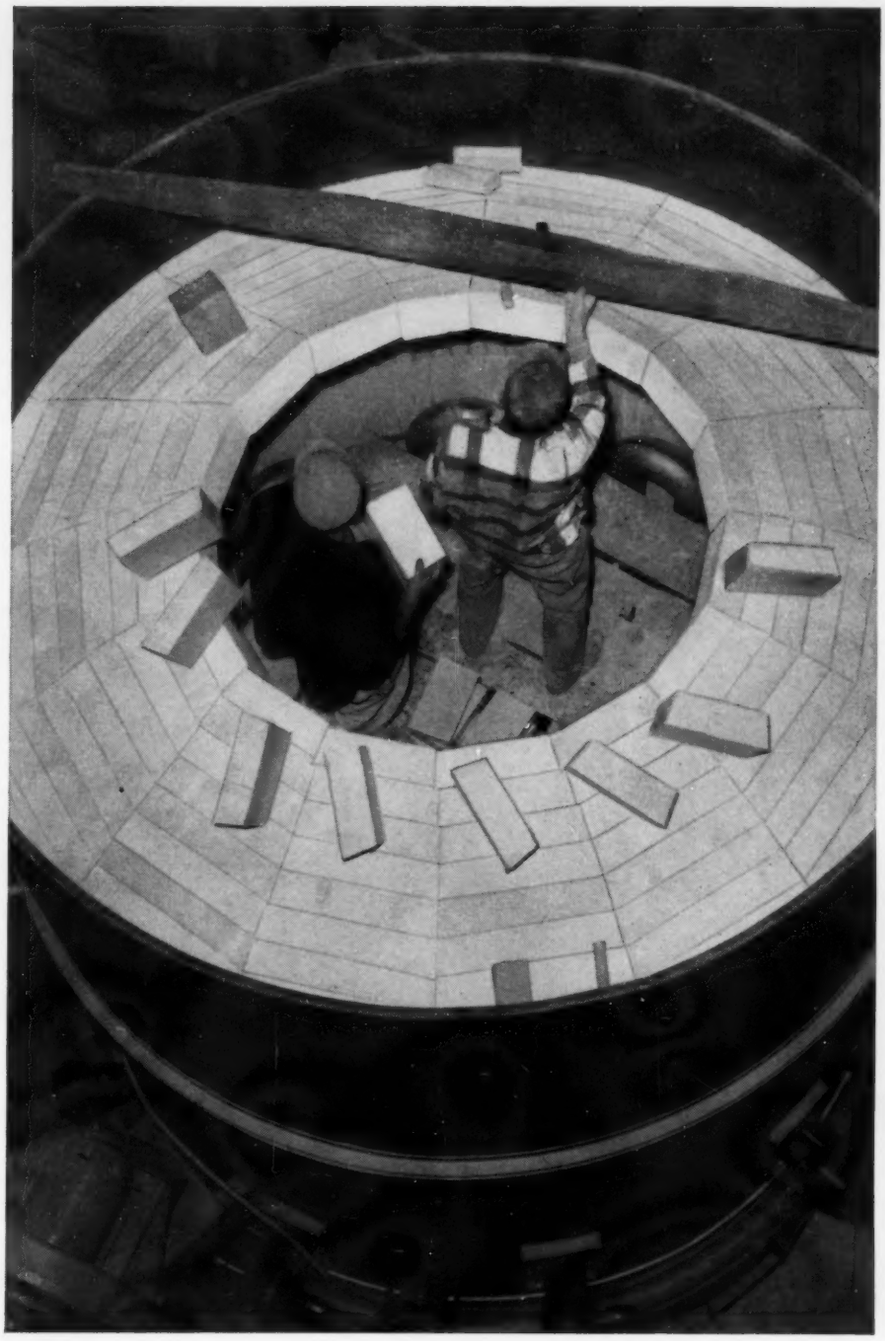
In heat-treating furnaces, at temperatures to 1900F, Johns-Manville Superex® Block insulation provides greater efficiency and long operating life . . . because of its unique combination of low conductivity and low shrinkage at elevated temperatures. Control of critical processing temperatures is reached *and held* more easily.

Especially formulated from diatomaceous silica and asbestos, the large, strong, lightweight blocks of J-M Superex are cut with such careful precision that a furnace dome will support the weight of several workers during construction...*without any cement being used!*

This ideal combination of performance advantages and production skill is the reason Lee Wilson Engineering Co., Inc., employs J-M Superex for wall and dome insulation. It will pay you to insist on J-M Superex in your high-heat equipment. Write for details to Johns-Manville, Box 14, N. Y. 16, N. Y. In Canada: Port Credit, Ont. Cable: JOHNMANVIL.



Inside Looking Up ...*view from below the dome of a Lee Wilson bell-type furnace. Note close fitting between Superex blocks. This dome actually supports installation workers' weight* . . . without use of cement!



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Large Size Blocks – 12" x 36" blocks speed application, reduce number of joints. Yet blocks are light in weight for ease of installation

Lightweight – only 24 lbs per cubic foot

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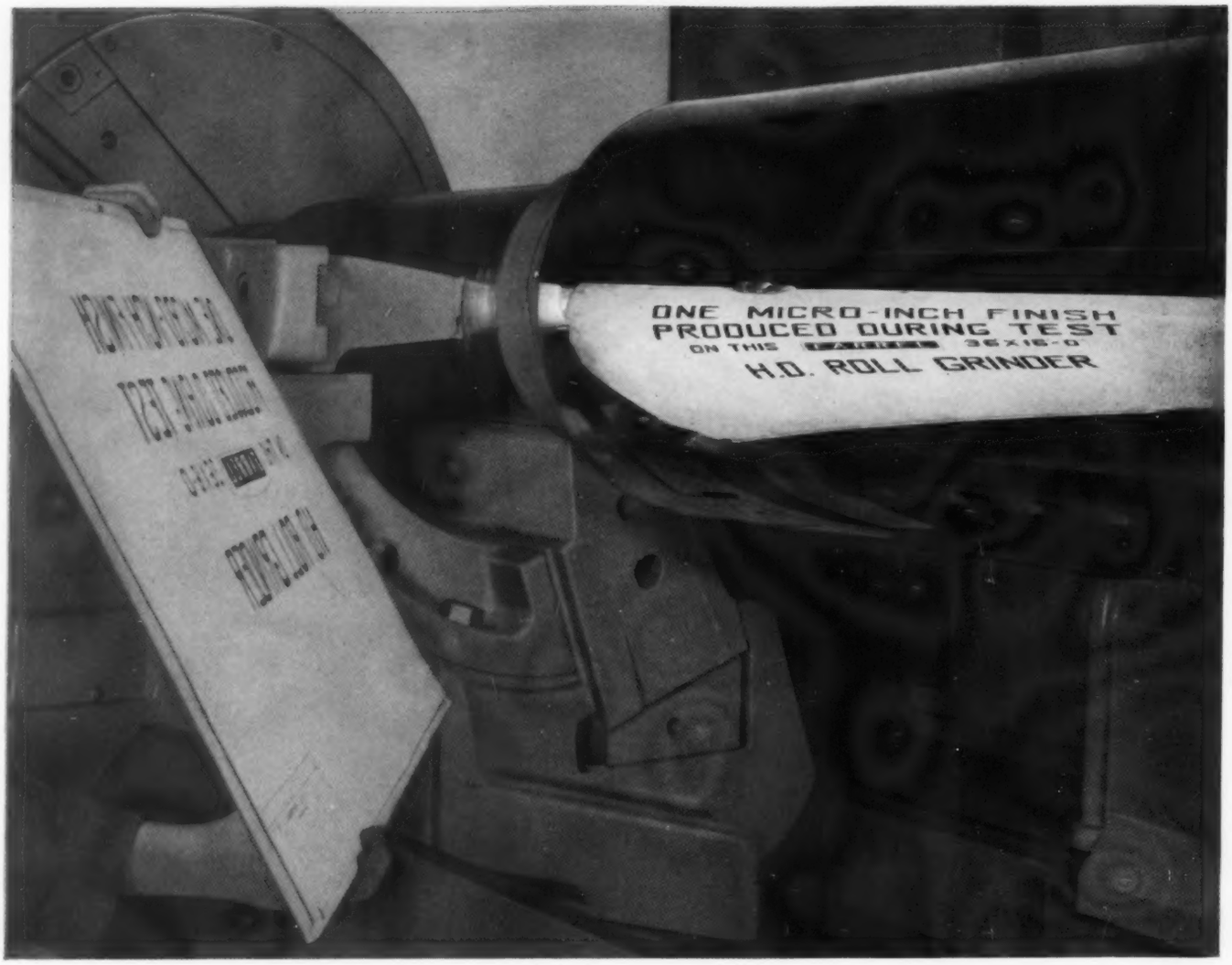


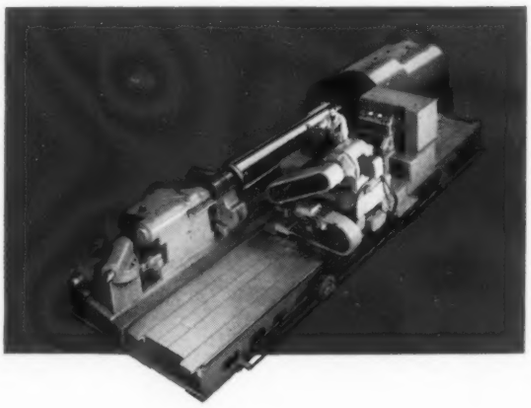
This roll reflects the precision in Farrel's new fine-feed grinding design

The roll you see above was photographed at the Farrel plant during a recent test of a grinder on order. Ground to a finish of one micro inch . . . or smoother than glass . . . this roll effectively demonstrates the amazing accuracy of Farrel's new heavy-duty roll grinder.

This machine incorporates the most significant roll-grinding improvement in twenty years: the new trunnion-tilt, pivoted, infeed system. This unique design has a wheelhead which is tilted into the work by means of the same support and leverage system that makes Farrel crowning the most accurate obtainable. Since the system is free of backlash, it permits positive wheel movement in either direction. In previous designs, accuracy was limited by friction resulting from a sliding wheelhead.

For manual operation, the infeed handwheel is graduated to .0001". A control stop enables the operator to withdraw the wheel as desired, then infeed it to precisely its former position.

For further details, send for a copy of bulletin 53DM.



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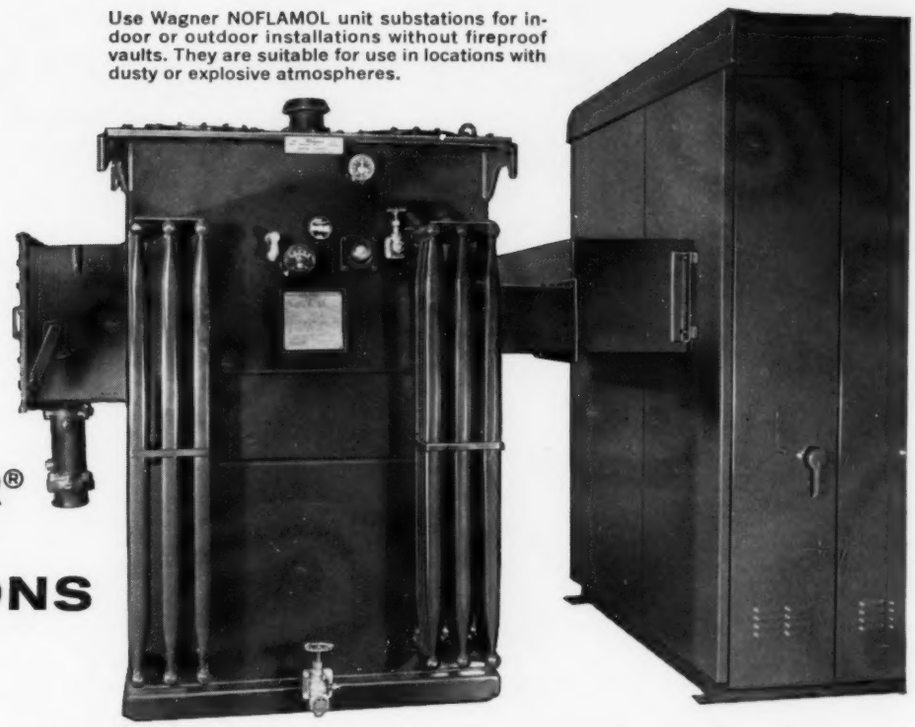

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An uninterrupted flow of power... that's the important thing in your buildings, be they sprawling, single-story factories or high-rise offices. You can't afford to be handicapped by substations that are unable to meet current or expanding needs... and you won't be, if those substations are Wagner® unit substations.

Designed to improve voltage regulation, and built to be troublefree, they are coordinated load centers that provide the flexibility needed to meet future load requirements. They consist of a proved Wagner transformer, universally acceptable interrupting devices, highly reliable air break switchgear, and metering equipment combined in perfect power packages. To simplify installation, they are factory tested and shipped completely assembled, ready for service. They economically deliver utilization voltage with shorter, less expensive conductor runs... lower maintenance costs with modern, protective enclosures... safeguard your valuable equipment with adequate interrupting capacity. And your substation investment is protected because one manufacturer has responsibility for all component parts.

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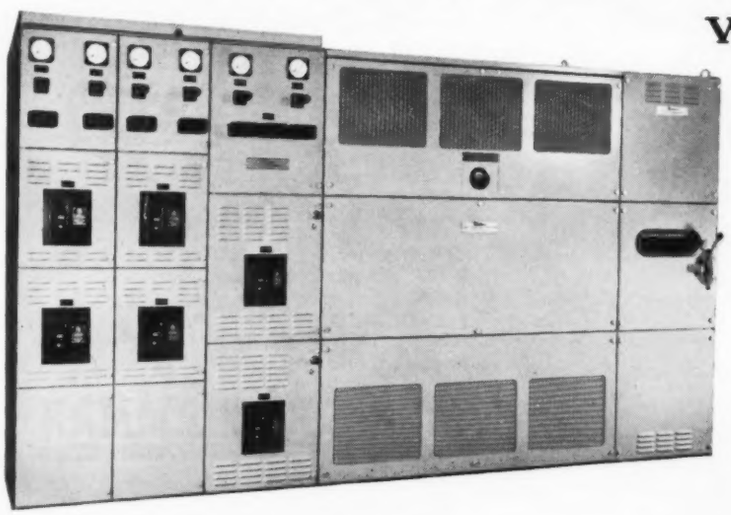
Four types per NEMA standards are available: sealed dry-type; ventilated dry-type; oil-filled; and Noflamol (non-inflammable liquid-filled).



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will be glad to help you plan your power distribution system. Get complete information on Wagner unit substations from him, or write us for Bulletin TU-152.

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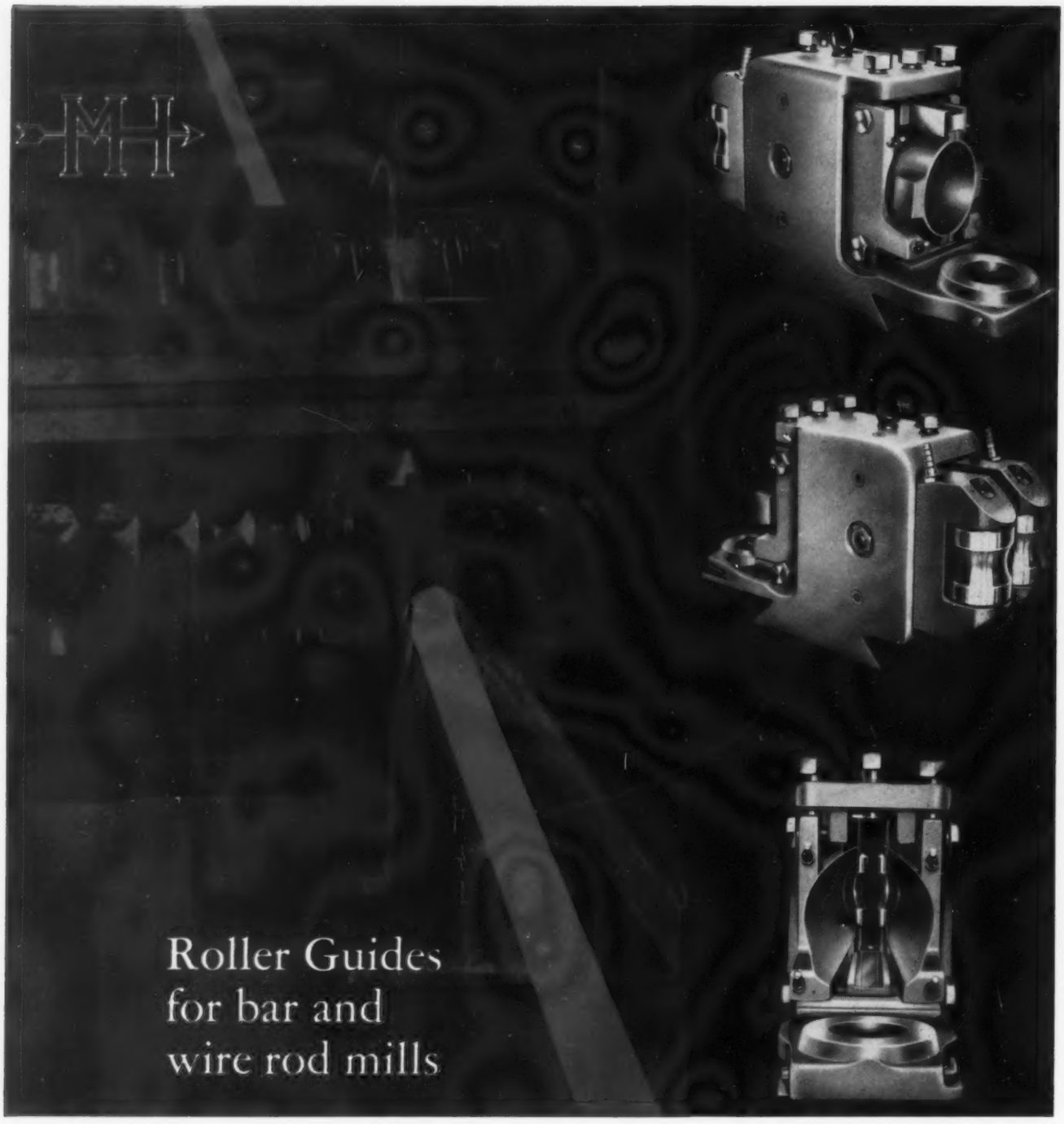

Morgårdshammar roller guides can be used for many sections such as leader and break-down ovals, squares, hexagons and octagons.

They can handle dimensions from about 3/16 in. (5 mm) round up to nearly 8 in. (200 mm).

You will obtain the following advantages with MH roller guides:

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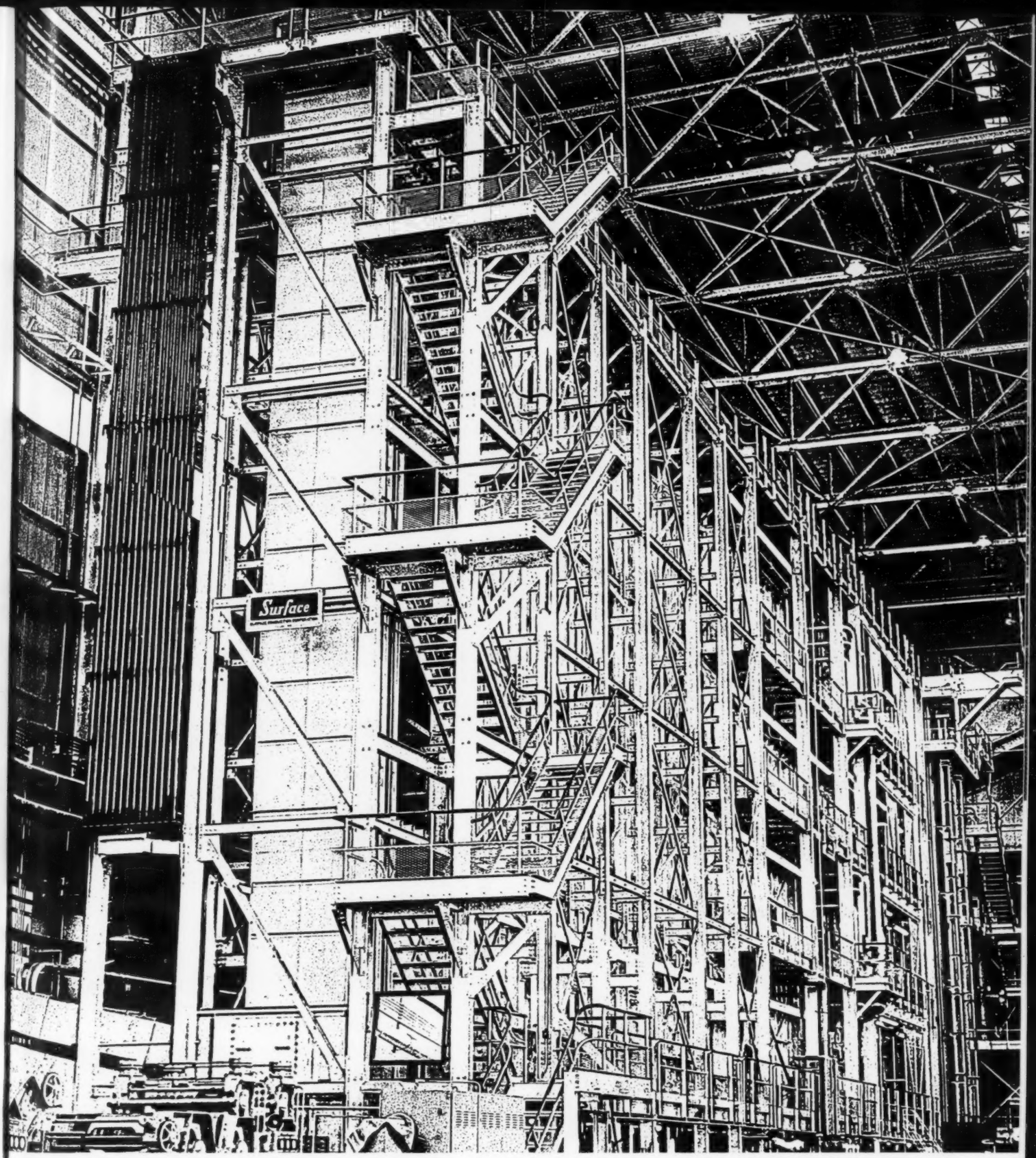


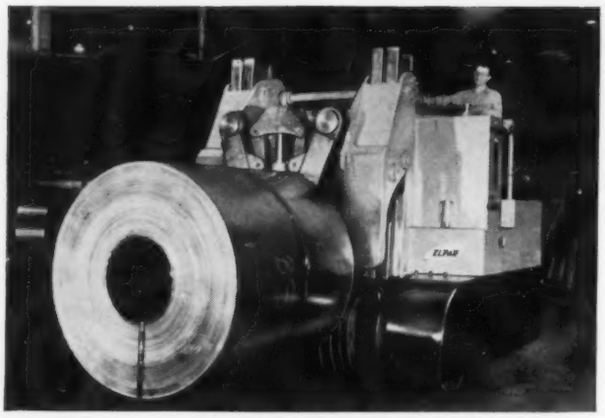
Courtesy Columbia-Geneva Steel Division, United States Steel Corporation

Sign of performance better than specified: The modern tin plate industry demands highest quality at lowest operating cost—requirements which can be met only with continuous annealing, a process pioneered by Surface. This Surface installation produces 96,000 lbs/hr of .010″ strip at speeds up to 1500 fpm. Address inquiries to 2404 Dorr Street, Toledo, Ohio.

SURFACE

SURFACE COMBUSTION, Toledo 1, Ohio/ a division of Midland-Ross Corporation MR

This 35,000-pound giant is shown handling huge aluminum billets—four at a time.



Another heavy duty ELPAR ram truck designed for handling steel coils. Built for handling efficiency and safety.

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This ELPAR Titan is designed to load coils weighing up to 20,000 pounds in box cars.

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patent reviews

by MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D.C., at 25 cents . . . patents reviewed cover period January 17, 1961 to February 14, 1961

REMOVING BURDEN FROM A BLAST FURNACE

△ U. S. 2,967,316, issued Jan. 10, 1961, to Charles W. Kandle, provides apparatus for removing burden from a blast furnace by means of a drill unit. The drill carried by the unit enters the furnace through the tuyères and the vibrations emanating from the unit causes the burden to move downwardly within the furnace to the removal zone, as shown in Figure 1.

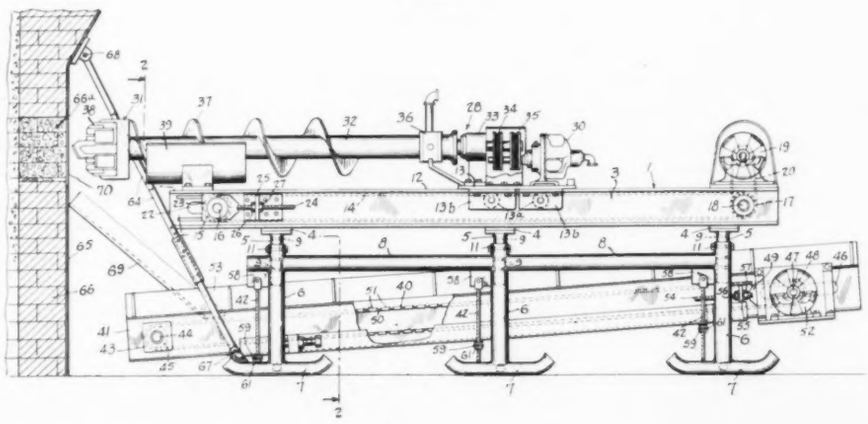
DESULPHURIZATION OF PIG AND CAST-IRON MELTS

△ U. S. 2,967,768, issued Jan. 10, 1961, to Fritz Harders and assigned to Dortmund-Horder Huttenunion A.G., provides a process for desulphurizing pig and cast-iron melts under vacuum.

As shown in Figure 2, the desulphurizing plant consists of a vacuum vessel 1, mounted on the stage B and lined with refractory brickwork 2 and enclosed air tightly by a metal jacket 3. The effective space 4 within the vessel may be relatively small.

A pipe 6 lined with refractory brickwork 5 opens into the bottom of the vessel 1. The end of the pipe is surrounded by refractory material 7 to the end of which a conical piece of sheet metal 8 is attached. The function of the cone 8 is to push aside any slag on the surface of the steel melt when the pipe 6 is introduced into it.

Figure 1



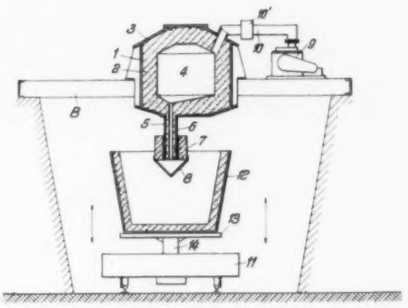


Figure 2

The pumping plant 9 which communicates with the effective space 4 in the vacuum vessel 1 through a pipe 10 is set beside the vacuum vessel 1 on the stage B. In the pipe 10 there is a device 10′ for freezing and recovering the sulphur compounds.

The pig or cast iron to be desulphurized is conveyed on a truck 11 to the vacuum vessel 1. A ladle 12 containing the melt stands on a platform 13 which can be raised and lowered by a hydraulic cylinder 14.

Figure 3 shows the conditions when a vacuum has been established in the effective space 4 in the vacuum vessel 1, and the ladle 12 standing on the platform 13 of the carriage 11 has been raised, thereby immersing the pipe 6 more deeply into the melt S of cast or pig iron. The cone S, which displaces the slag, has meanwhile melted and a part

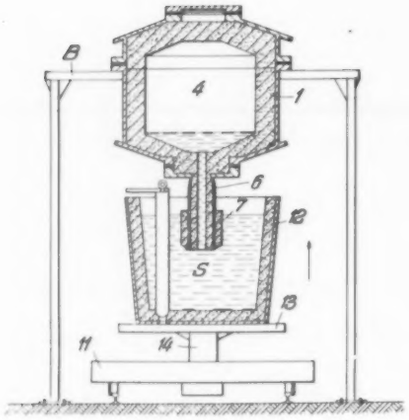


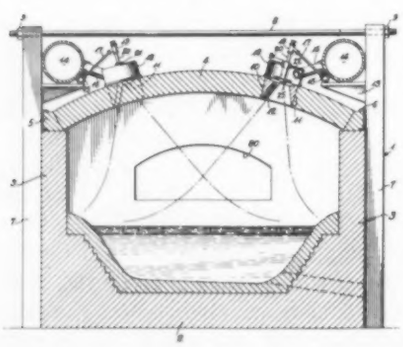
Figure 3

of the contents of the ladle has been raised by atmospheric pressure. In this process, the space 4 in the vacuum vessel 1 has filled up to the extent shown in the drawing.

When this part of the pig or cast iron has been kept under vacuum for some time, the ladle 12 is lowered without altering the vacuum in the vessel 1. The metal thereby flows back into the melt remaining in the ladle 12, with the exception of some residual metal which remains in the pipe 6. The raising and lowering of the ladle and the consequent inflow and discharge of a part of the pig iron present in the ladle 12 is repeated until the entire contents of the ladle have been desulphurized to the desired extent.

It was found that the desulphurization of pig and cast iron in a vacuum can be markedly accelerated and increased in extent if it takes place in the presence of free carbon in the form of carbon which is practically free from sulphur or contains little sulphur, e.g., electrode carbon, which is charged before or during the desulphurizing treatment in the form of a coarse powder or in pieces up to the size of a walnut, onto the surface of the pig and cast-iron melt.

Figure 4



OPERATION OF A TOP-FIRED OPEN HEARTH FURNACE

△ U. S. 2,970,829, issued Feb. 7, 1961, to Charlton Reynders, describes a method of operation of a top-fired open hearth furnace in such a way as to prevent excessive losses in refractory linings.

It has been found that the velocity of the flame in such furnaces is a factor of extreme significance, that the height of furnace roof above the bath is of vital importance when controlling the flame velocity and, that there is a definite correlation and ratio between such roof height and flame velocity.

The patent sets forth the relations of these variables, with respect to apparatus of the type shown in Figure 4.

APPARATUS FOR CASTING STEEL INGOTS

△ U. S. 2,970,351, issued Feb. 7, 1961, to Frank Rice and assigned to Jones & Laughlin Steel Corp., provides apparatus for adding predetermined quantities of solid addition materials such as lead to steel ingots and withdrawing objectionable fumes or gases evolved.

The apparatus is shown in Figure 5. Bin 20 is kept supplied with lead shot of the proper size. Reservoir 15 in crane cab 14 is filled by moving the crane 9 until filler pipe 17 of reservoir 15 is opposite discharge pipe 21 of hopper 20. The two pipes are then connected and lead shot allowed to feed by gravity into reservoir 15 until the latter is filled. When a heat of steel is to be cast into ingots, ladle 4 is filled with molten steel in the usual manner and positioned above ingot 1 of successive ingot molds, mounted on mold buggy 2. Hood buggy 41 is connected to crane cab 14 by connecting bar 75. Nozzle 27 is held by a worker in a U-shaped notch on bracket 77 which positions nozzle 27 directly above ingot mold 1 which will be filled by molten steel leaving ladle 4 through tap hole 5. Automatic feeder 22 is set to deliver the desired weight of lead shot in the desired time for the size ingot to be cast. When molten steel begins to flow through tape hole 5 into ingot mold 1, the automatic feeder 22 is set in operation by the proper control on panel 23 and begins delivering lead shot through conduit 25 and hose 26 to

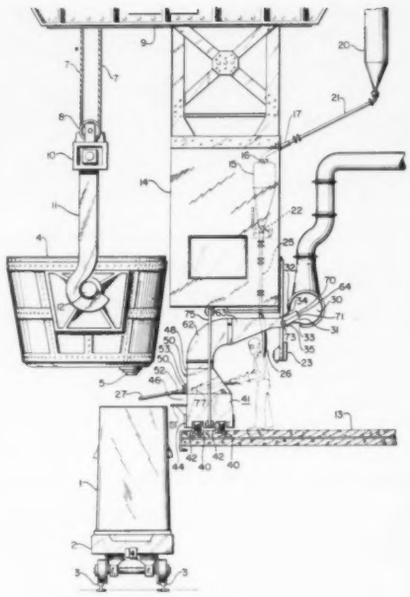
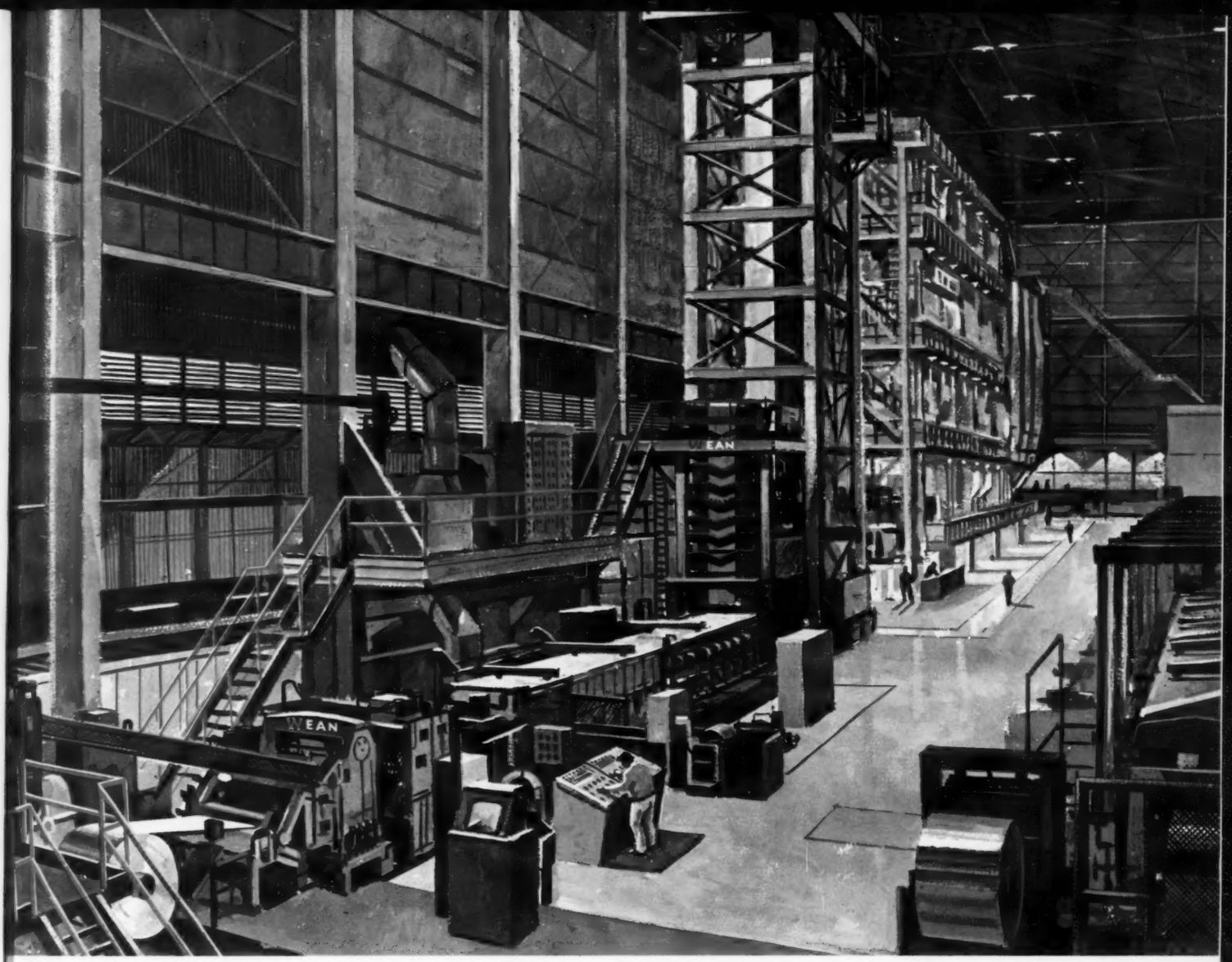


Figure 5

nozzle 27 from which it is directed into the stream of molten metal from the ladle 4. A blower is started up so as to exhaust the atmosphere from collector pipe 30. Pipe 30 is normally closed by flexible flaps 34 and 35 and the atmospheric pressure tends to force these flaps together, sealing collector pipe 30 except in the region where the open end 64 of duct 63 is positioned between flaps 34 and 35. Through this open end 64 the atmosphere from the associated ducts and chamber 43 on hood buggy 41 is exhausted through collector pipe 30. Upper and lower flanges 51 and 52 of hood buggy 41 extend the duct system toward ingot mold 1 so as to minimize the escape of fumes.

SHEET LAPPING APPARATUS

△ U. S. 2,971,630, issued Feb. 14, 1961, to Clyde D. Michaels and assigned to United States Steel Corp., provides sheet lapping apparatus used in conjunction with an electrolytic tinning line. The discharge end of such lines is equipped for automatic shearing, classifying and piling of the tin plate. The plates pass over a system of conveyor belts which permit the deposition of the sheets into reject, mender and prime piles. Two or more belt conveyors at different levels are arranged to separate defective sheets from prime sheets. To facilitate stacking of the sheets at the end of these conveyors, it is necessary that the sheets be lapped or shingled. The lapping of



PORTRAIT OF PROGRESS: *Wean Tin Plate Annealing Line at J&L's Aliquippa Works*

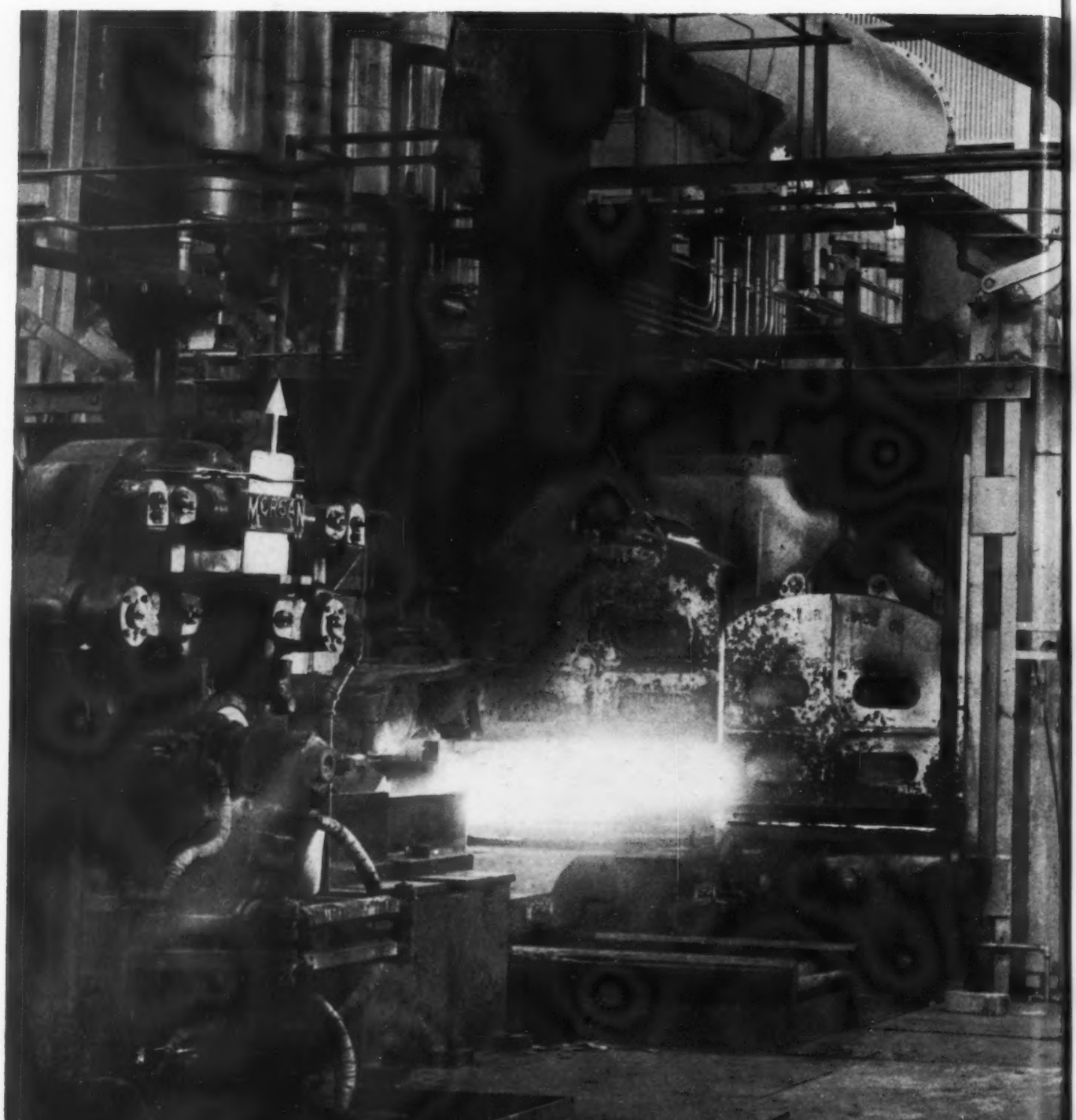
J&L Cuts Production Time, Improves Quality with Wean Tin Plate Annealing Line

Jones & Laughlin Steel Corporation's new Wean tin plate annealing line is a major part of the company's tin mill modernization at Aliquippa. Continuous annealing on the Wean line enables J&L to fill tin plate orders far more quickly than was possible with the slower batch annealing process. And the Wean line gives uniformly annealed strip for higher quality finished output.

Operating at speeds up to 2,000 fpm, the line can handle 50,000 lb. coils with a maximum O.D. of 85". Accurate *zoned* tension control is maintained by passing the strip through six, electrically-interlocked, precision bridles. A unique system for removing heavy-end scrap utilizes two uncoilers which may be shifted laterally to permit winding the heavy ends on a scrap reel located outside of the line.

Wean "creative engineering" has accounted for much of the development work that has established continuous annealing as a standard processing operation in the steel industry. The Wean Engineering Company pioneered in this field and has built more continuous annealing lines than all other manufacturers combined. This experience is ready to serve you.

THE WEAN ENGINEERING COMPANY, INC. · WARREN, OHIO



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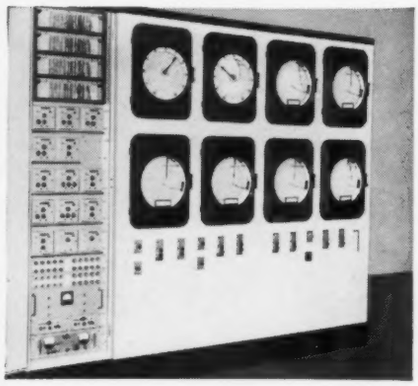

FIRST IN THE STEEL INDUSTRY AT BETHLEHEM'S STEELTON WORKS

A two-zone Rust billet-heating furnace at Bethlehem's Steelton Plant is equipped with Hagan PowrMag® (magnetic amplifier) electronic controls. Hagan systems on this new furnace include zone temperature, fuel/air ratio, furnace pressure, air pressure, and recuperator temperature balance control.

Using Hagan PowrLog® recorders and PowrMag controllers, the system provides for parallel operation of combustion air dampers and fuel oil control valves in each zone. An unusual feature of the furnace is the two stack-type recuperators. These must have waste gas flow regulated so that temperatures are equal in each recuperator, and this must be accomplished by the same dampers that regulate furnace pressure. The control system accomplishes this by using furnace pressure as the primary control impulse, moving both stack dampers in parallel. Temperatures in both stacks are continuously sensed, and a controller moves one of the dampers to maintain the two temperatures at the same level.

This installation is a part of the move towards more centralized control that has interested the steel industry for some time. A Hagan engineer will be glad to discuss how this principle can be applied to your plant. Or, ask for Bulletin MSP-163. Write or phone:

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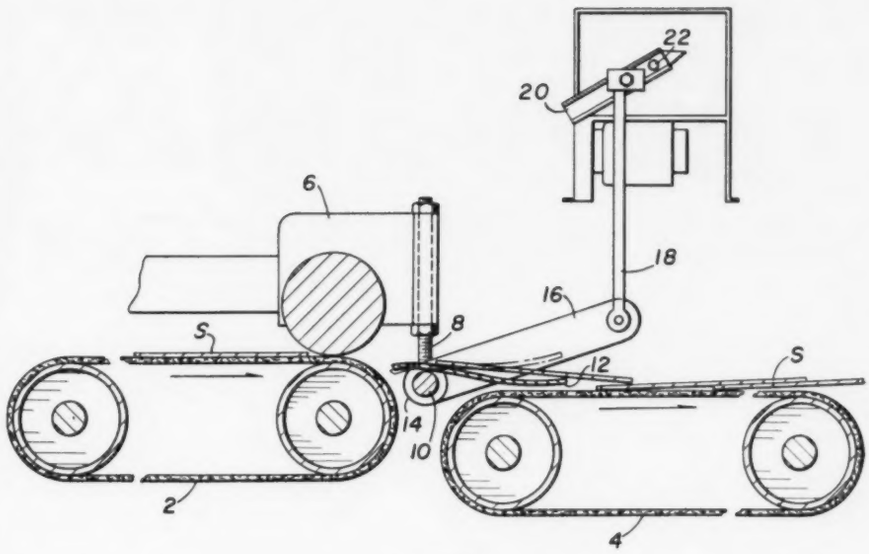

Figure 6

sheets is obtained by operating the two conveyors at different speeds, the entry conveyor operating at a higher speed than the exit or sheet receiving conveyor.

The apparatus is shown in Figure 6. Means are provided for adjusting the height of the shingling plate in accordance with the speed of the processing line or conveyors.

REFINING OF FERROUS METAL

△ U. S. 2,969,282, issued Jan. 24, 1961, to Thomas C. Churcher and assigned to The British Oxygen Co. Ltd., relates to the treatment of molten ferrous material by allowing the material in subdivided form to fall freely through a reaction space constituted by the interior of a refractory-lined tower in contact with a stream of an oxidizing gas. Such a process may, for example, be used for the removal of impurities such as carbon, silicon, manganese, phosphorus and sulphur, either as a pretreatment to be followed by subsequent operations or to produce metal of a desired composition.

It is an object of the invention to reduce the amount of fume leaving the reaction space. The escape of fume from the reaction space is reduced by utilizing the injector action of the oxidizing gas fed to the reaction space to withdraw at least part of the fume from the reaction space at a point remote from the oxidizing gas inlet or inlets and to re-

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,968,075	1/17/61	Hot metal valve	William E. Fleckinger, Sr., et al.
2,968,092	1/17/61	Process of working steel to surface defects	Yawata Iron & Steel Co., Ltd.
2,968,451	1/17/61	Control for an uncoiler	United States Steel Corp.
2,968,549	1/17/61	High-temperature steel alloy	United States Steel Corp.
2,969,700	1/31/61	Rolling mill	Thompson Ramo Wooldridge, Inc.
2,969,873	1/31/61	Double billet extrusion press	Schloemann A.G.
2,969,884	1/31/61	Device for handling a repair piece for a furnace	United States Steel Corp.
2,970,689	2/ 7/61	Coal treating process	Crucible Steel Co. of America
2,970,902	2/ 7/61	Ductile iron	International Harvester Co.
2,970,903	2/ 7/61	Alloy steel having surface free from alligatoring	American Steel Foundries
2,970,949	2/ 7/61	Coke oven	Allied Chemical Corp.
2,971,032	2/ 7/61	Recovery of phenol from a coke plant ammoniacal liquor	Walter J. Podbielniak
2,971,410	2/14/61	Roll mounting for a draw rolling mill	A. O. Smith Corp.
2,971,557	2/14/61	Sheet and plate stretching apparatus	United Engineering & Foundry Co.
2,971,871	2/14/61	Annealing furnace seal	Midland-Ross Corp.
2,971,895	2/14/61	Regenerative coke oven batteries	Koppers Co., Inc.
2,972,039	2/14/61	Pressure control for tube mill	The McKay Machine Co.
2,972,040	2/14/61	Manufacture of longitudinal seam welded pipes	Hans Thierfelder

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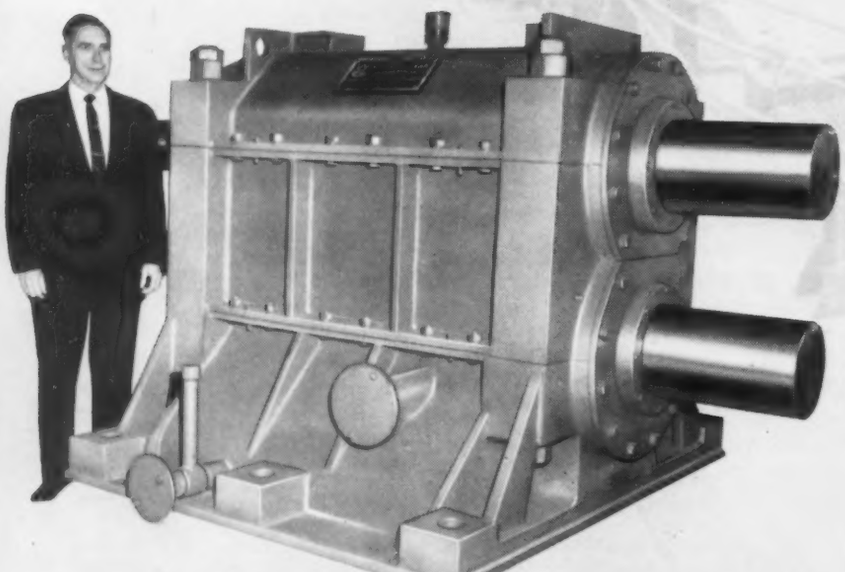

Finished 2-high pinion stand

Engineering Facts

24" center distance – 2-high pinion stand
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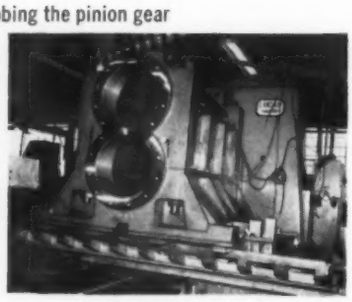
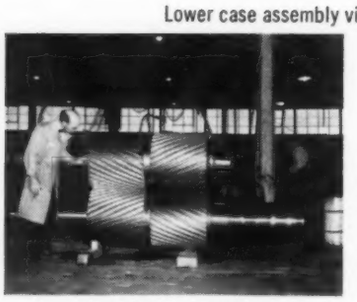
Hobbing the pinion gear

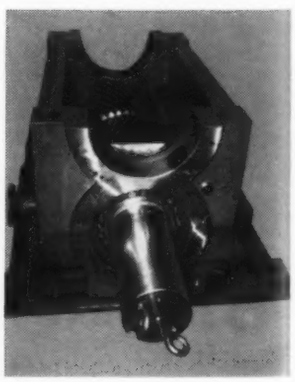


Milling the case

Lower case assembly view



Inspecting gear finishes



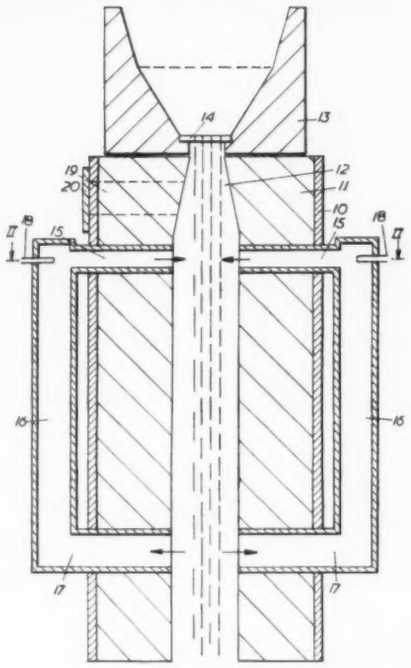


Figure 7

turn the withdrawn fume to the reaction space entrained in the oxidizing gas.

As shown in Figure 7, oxidizing gas is fed into the reaction space 12 through nozzles 18 and the inlets 15 and a charge of molten metal is poured into the crucible 13. The metal leaves the crucible and enters the top of the tower through the perforated plate 14 by which it is divided into droplets. The subdivided metal falls through the reaction space 12 under gravity in concurrent contact with a stream of oxidizing gas, which entering through the inlets 15 passes downwardly through the reaction space. In its passage through the reaction space, the subdivided molten metal is refined by reaction with the oxidizing gas, impurities in the metal being oxidized and a certain amount of the iron being converted to finely-divided iron oxide which is suspended in the gas stream passing downwardly through the reaction space to form the characteristic brown fume.

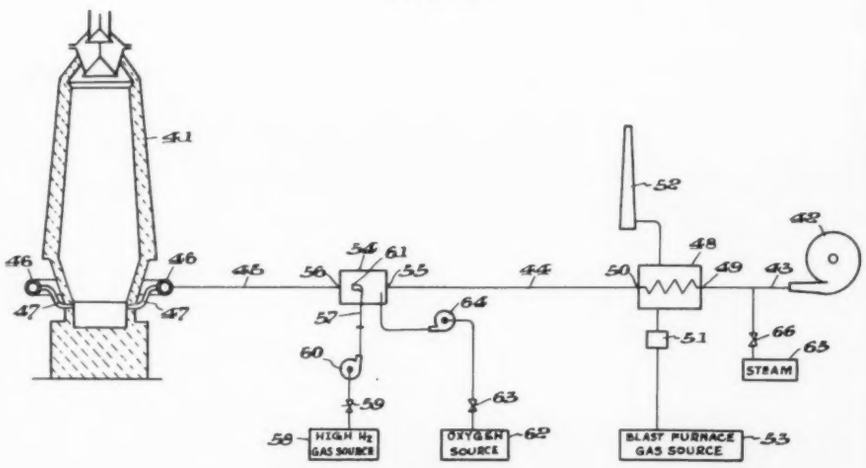
A part of this fume is withdrawn through the ducts 17 and 16 by the injector action of the oxidizing gas streams leaving the nozzles 18 and is entrained in these oxidizing gas streams and with them recycled to the reaction space 12 through the inlets 15.

HEATING AND HUMIDIFYING AIR FOR BLAST FURNACES

△ U. S. 2,970,901, issued Feb. 7, 1961, to Owen R. Rice and assigned to Koppers Co., Inc., provides a method of heating and humidifying the blast of air to a blast furnace.

The present invention provides a process of preparing the blast which reduces the cost of steam for humidifying the blast by forming about one half of the amount of water vapor for humidifying the hot blast during the supplemental heating of the same to higher temperature of 300 F or more to augment the heat of the blast. This is done by burning high hydrogen containing gas in amounts to supply half the humidity directly in the hot blast, thereby forming about one half the amount of water vapor in the blast as a product of the combustion. A high degree of humidity is attained with a reduction in cost for the steam since the additional water vapor is formed as the product of combustion that produces the higher temperature in the blast. The method is shown diagrammatically in Figure 8.

Figure 8



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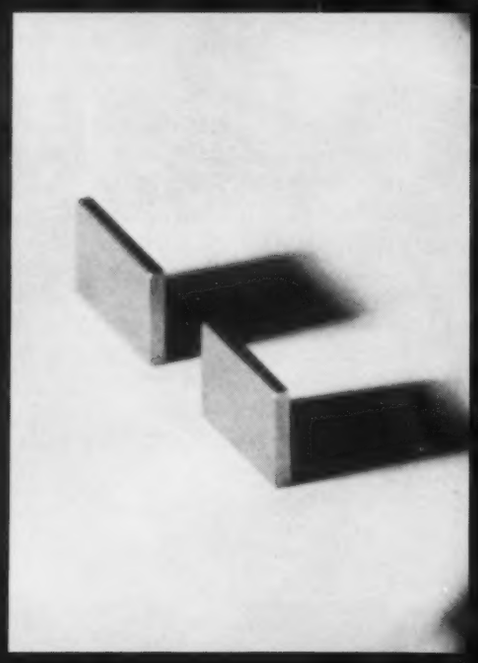

Good anti-wear properties assure long pump life—PYROGARD C fire-resistant fluid is designed for most pumps and pressures encountered in mill hydraulic equipment . . . gives excellent protection against pump wear for fluids of this type. Pump vane at left is new. Vane at right has 1000 hours of service with PYROGARD C at 160F and 1000 PSI. Wear is almost undetectable.

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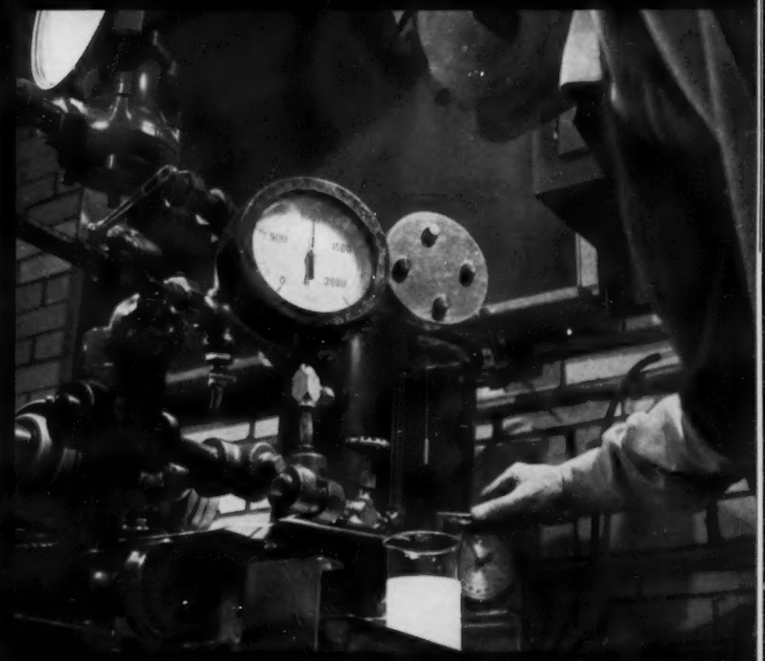

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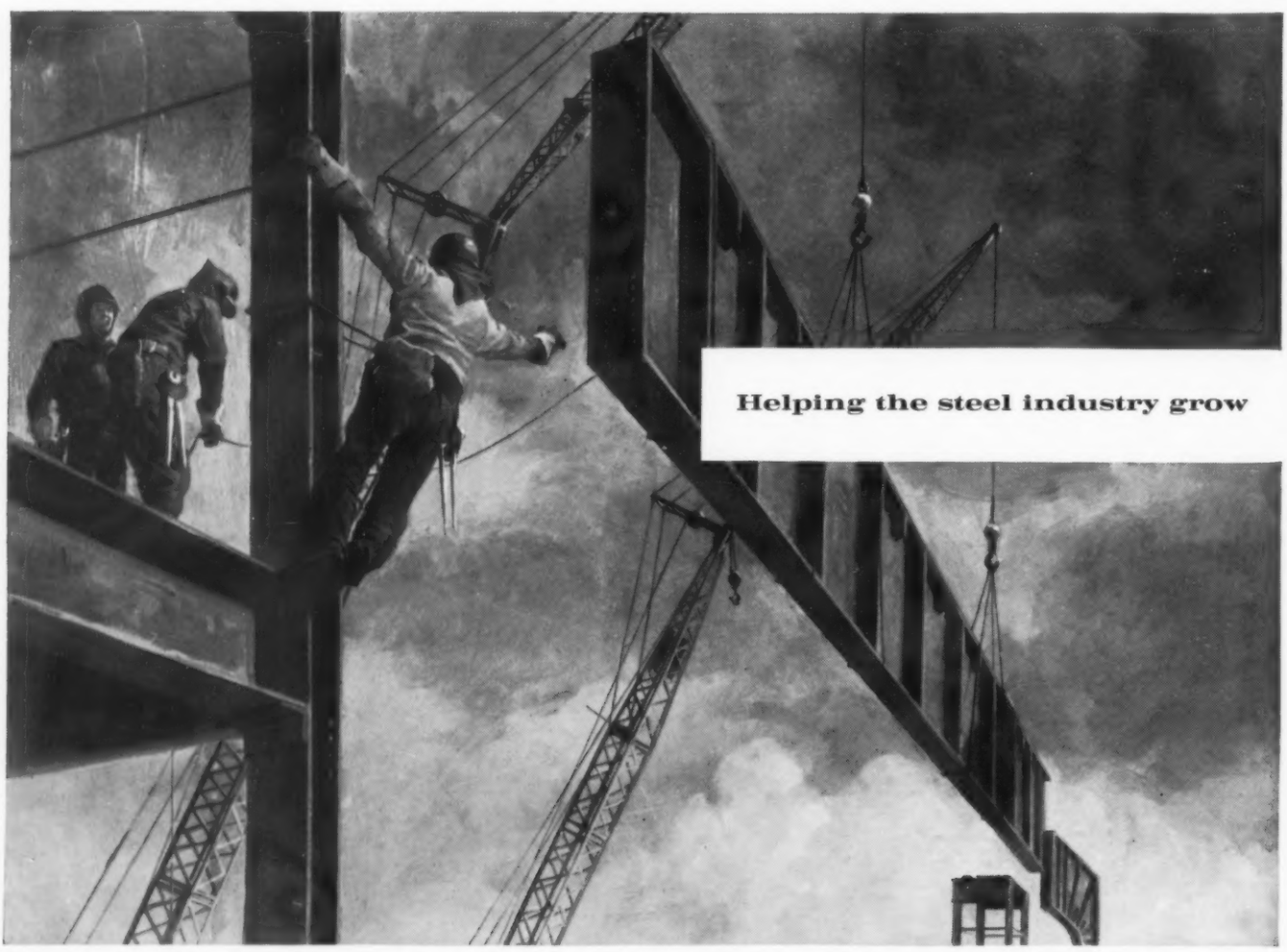

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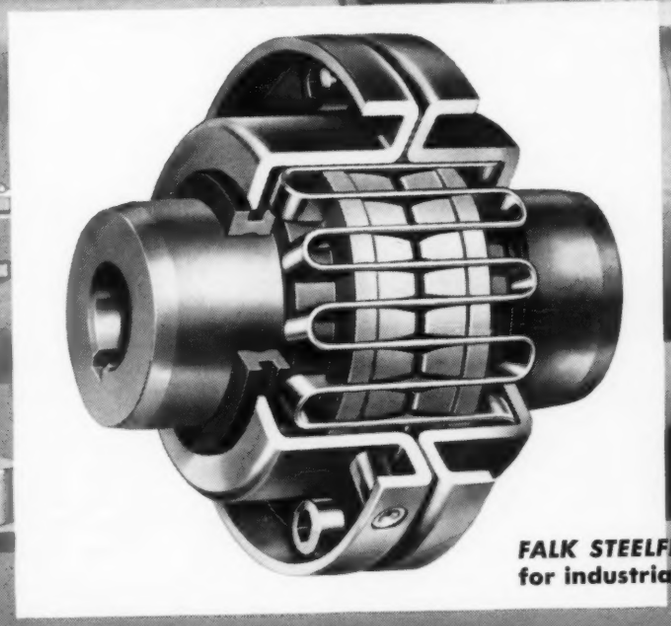

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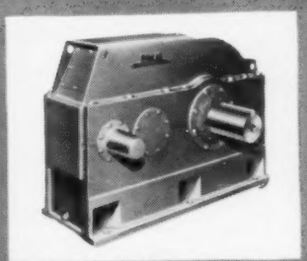

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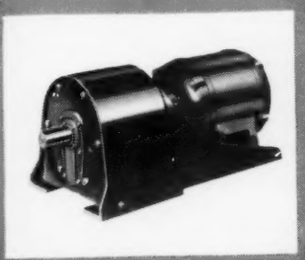

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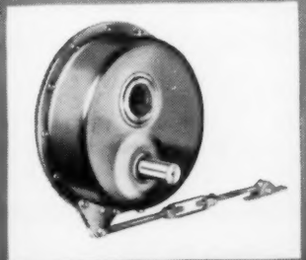

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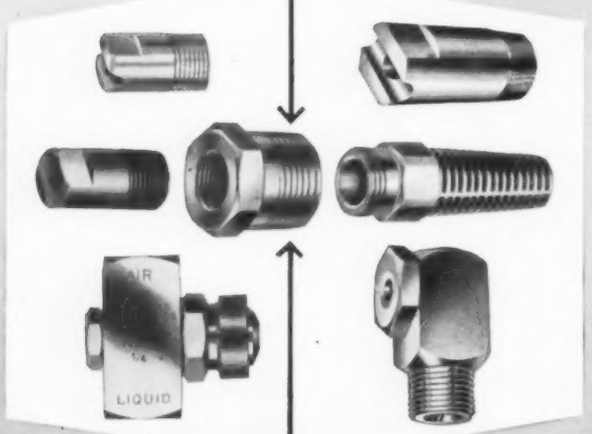

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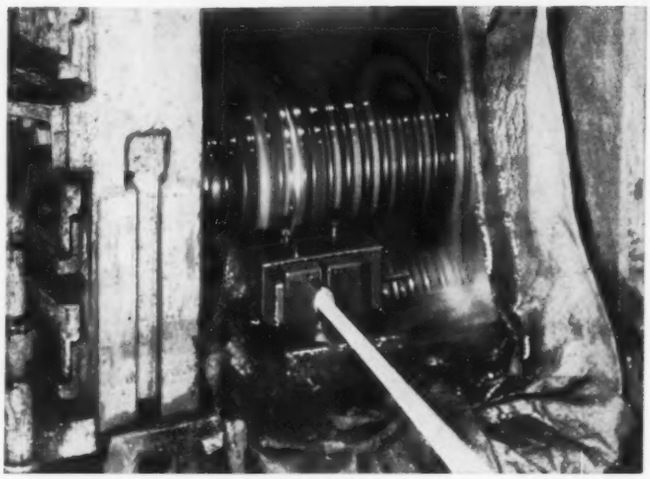

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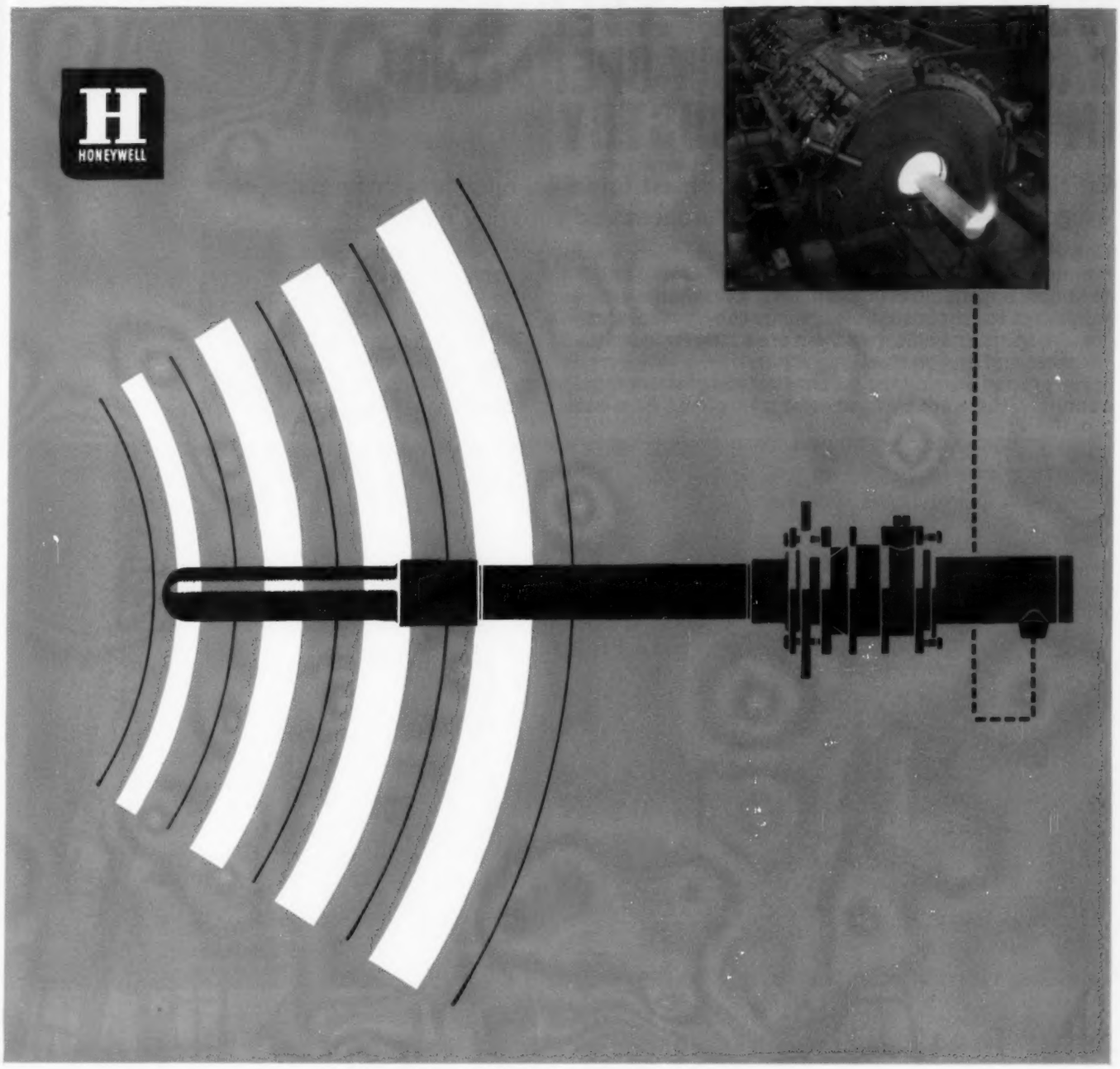

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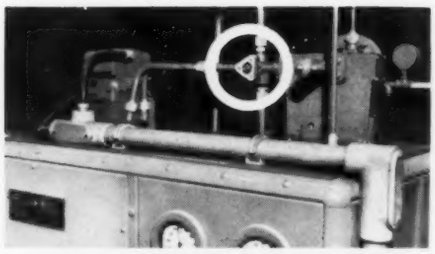

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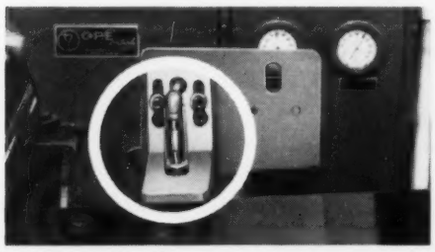

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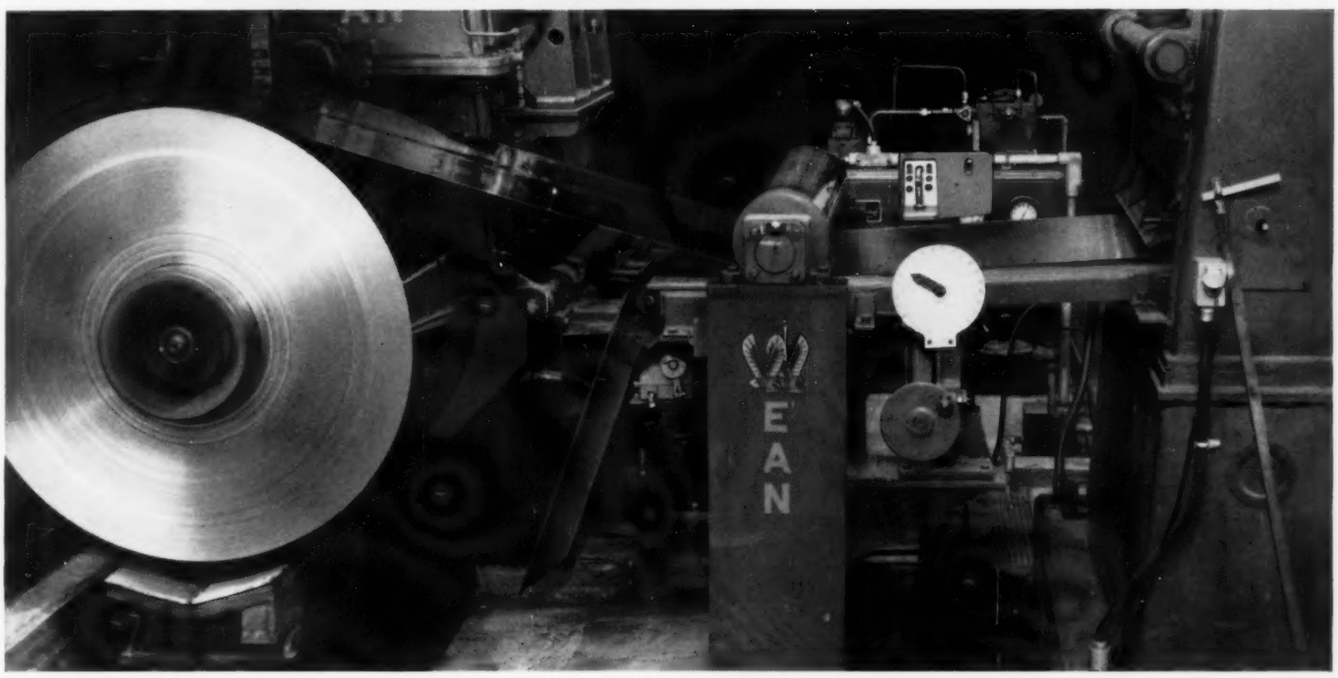

High-finish tinplate line at Granite City Steel uses GPE Controls Edge Guide for mirror-edge wind-up coil

This GPE Controls air-hydraulic strip guide – on the "B" Electrolytic Tin Line at Granite City Steel – is one of the four similar units now operating in this modern mill. And *three more* GPE Controls Strip Guiding Systems will soon be in operation.

Here at the wind-up, the line operates at about 1000 feet per minute. GPE Controls Strip Guide continuously positions the wind-up reel to produce a mirror-like metal edge on the wind-up coil. Tinplate quality is protected in handling and shipping because the coil edge is perfectly smooth!

Steelmakers and steel users alike have shown their preference for GPE Controls by making it the most widely used strip guide. For simplicity, for control accuracy, for construction that cuts maintenance to the bone–you can't beat GPE Controls!

Write for informative Bulletin EG84

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With 16 solution tanks, 6 flash-bakers, the Cleaning Line offers complete flexibility for treating low-carbon, alloy or spring wire and applying borax, lime or copper sulfate coatings.

Unique cleaning line at Donora Works speeds rod processing under Speedomax H control

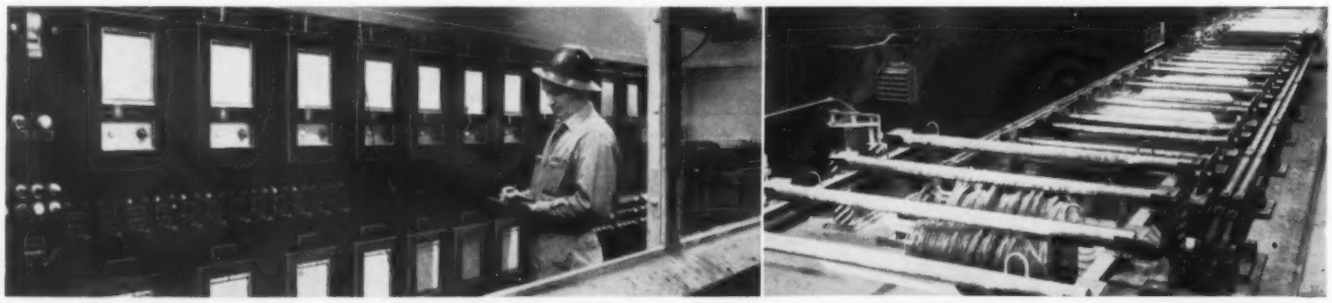
Clean, rinse, coat, bake . . . combining the flexibility of a batch operation with the smooth efficiency and high output of a continuous process. That's the performance of the rod-cleaning line at Donora Works, American Steel and Wire Division of U.S. Steel—a significant step in their major modernization and expansion program.

With 5000-pound pins of rods clock-card scheduled for processing through the line, there must be no delays — and Donora Works depends on Speedomax H to hold solution and flash-baker temperatures at optimum values, regardless of the load program.

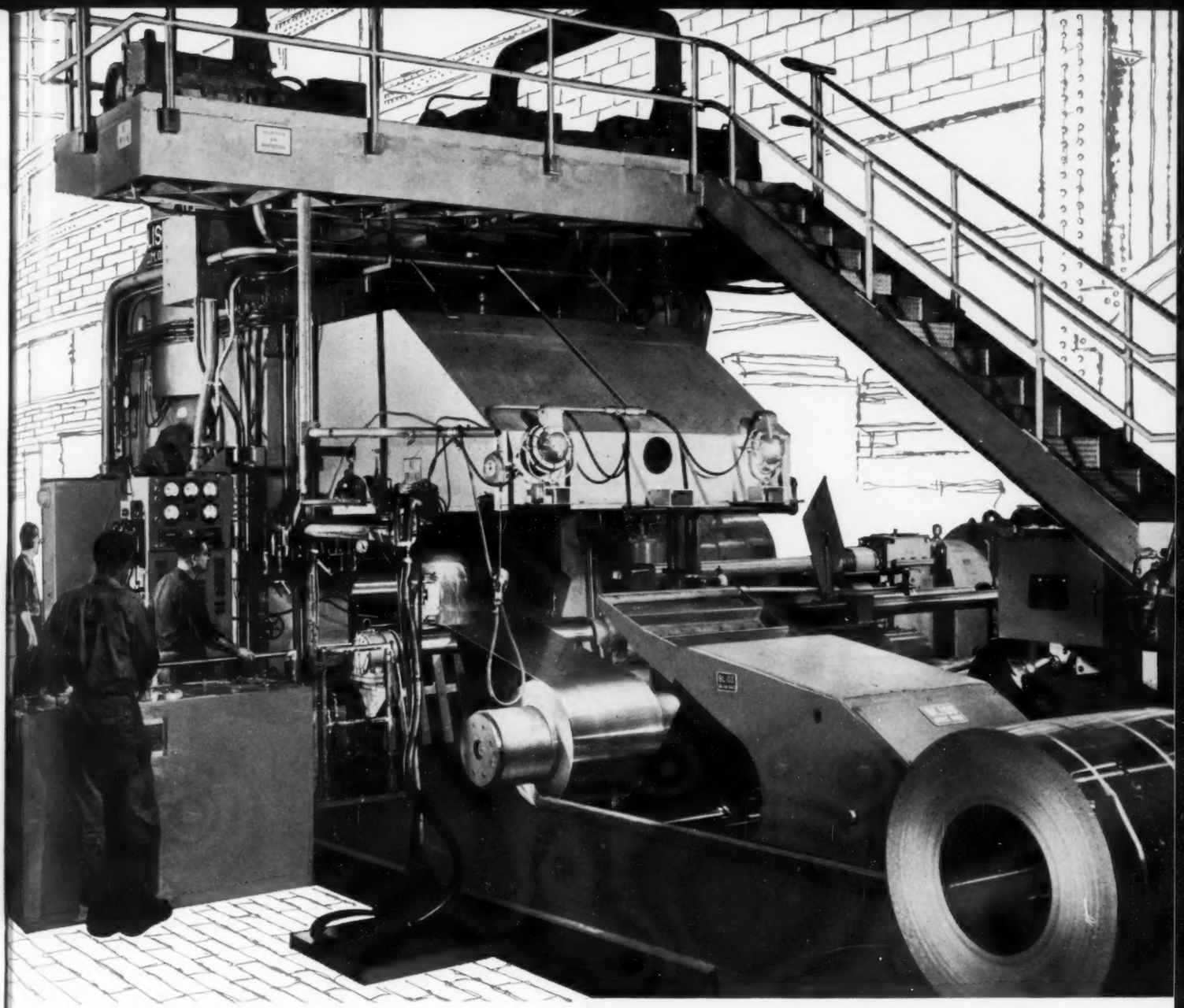
Compact enough to save panel space, precise enough to suit exacting measuring and control requirements, sturdy enough to stand up to rugged shop conditions, this Speedomax H instrument is increasingly used for a variety of applications throughout steel plants, foundries, and the metal-working industry.

To investigate the potential of Speedomax H for expansion or modernization of *your* facilities, simply contact the L&N office near you, or write us at 4942 Stenton Avenue, Philadelphia 44, Pa.

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces



In this compact control room Speedomax H controllers keep steam-heated solution tanks at optimum temperatures, and monitor flash-baker temperatures for drying coated rods in minutes.



SAYS ANACONDA ALUMINUM:

One good mill deserves another

Picking a Bliss rolling mill for their new aluminum plant in Terre Haute, Indiana, was easy for Anaconda Aluminum Company: for years these mills have had an outstanding performance record in the aluminum industry.

A new Bliss 14″ x 49″ x 66″ four-high one way cold mill capable of speeds up to 1200 fpm, it is equipped with the auxiliaries necessary to produce aluminum coiled sheet in 60″ widths and at specified thicknesses as fine as .006″. Bliss supplied the mill with complete entry and delivery equipment, including entry coil conveyor, coil lowering device, coil preparation station, mandrel-type payoff reel, coil buggy, and tension reel and coil buggy.

Anaconda's operation brought the "best" out of the Bliss mill as plant management found its production record to be excellent and economical, too. This installation is just one more example of the acceptance of Bliss rolling mill equipment. For others, in both ferrous and non-ferrous operations, write us today for a copy of our 84-page Rolling Mill Brochure, Catalog 40B.

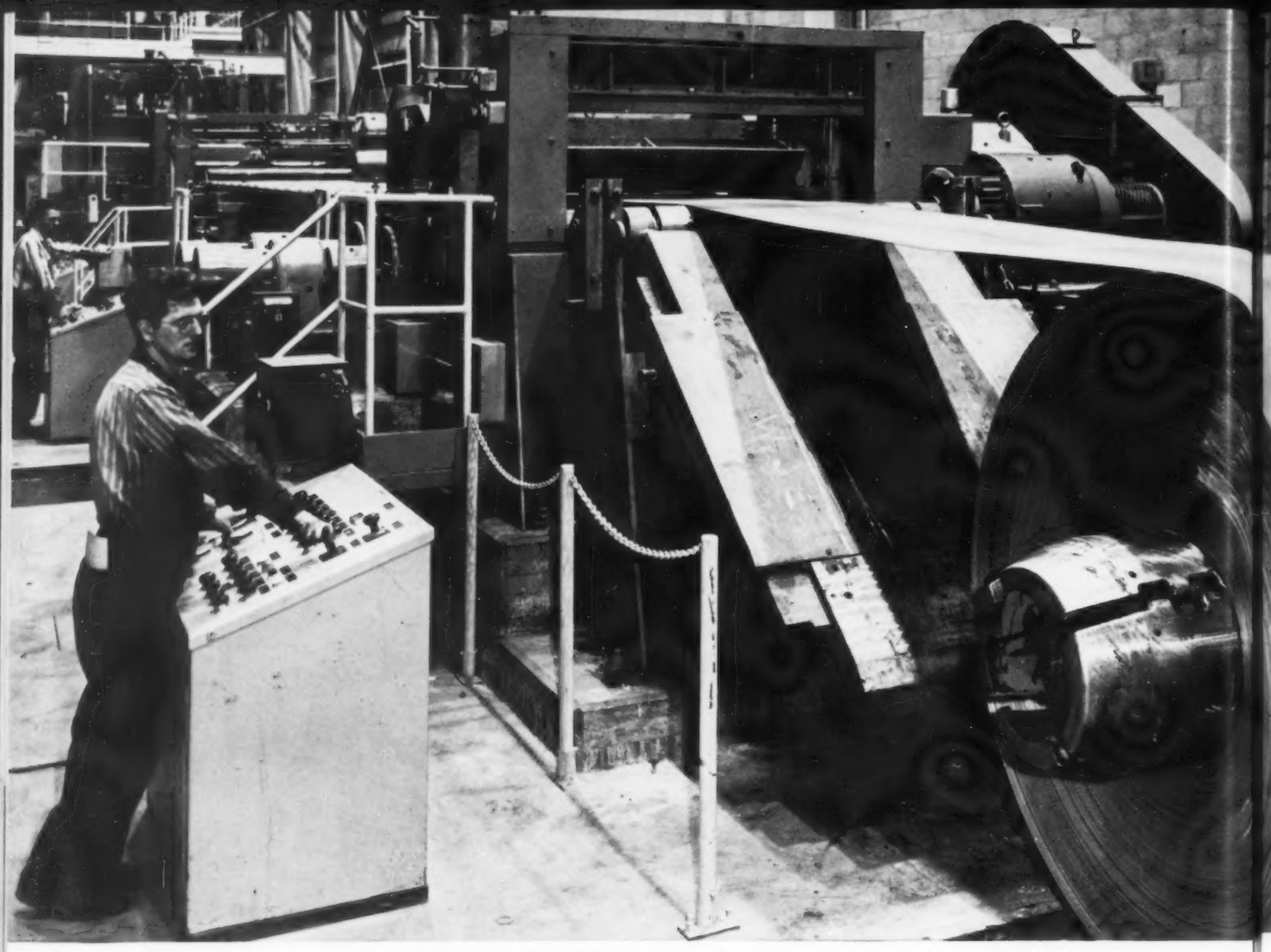
BLISS
SINCE 1857 ®

Bliss is more than a name . . . it's a guarantee

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Rolling Mills • Mill Auxiliaries • Amerigear/Bliss Flexible Spindles

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio



Feeding in strip at the entry reel of a galvanizing line in Hamilton, Ontario.

SINGLE RESPONSIBILITY FOR DRIVE SYSTEM DESIGN PAYS OFF FOR CANADIAN MILL

The motors, controls, regulators and sensing devices which drive this continuous galvanizing line were integrated to produce a precise performance by one totally responsible source . . . Reliance Systems Engineering.

The drive system was designed to utilize sectional generators and control, thus achieving more flexibility to handle a broader range of products. Any or all units of the line consequently can be changed to meet new production demands. Positive speed sychronization between sections is achieved with Reliance transistorized VSRR magnetic amplifier regulators.

Close control of the line is demonstrated by application of modern sensing devices. When light gauge strip is coiled, for example, a Reliance "Tensitron", senses, establishes and maintains tension at pre-set levels.

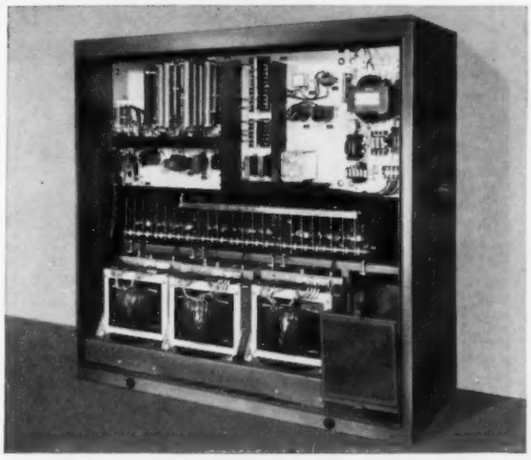
Precise tension and tracking of the strip was quickly created and preserved throughout all 32 sections of the line . . . and uniform, high quality strip was produced. Reliance willingly accepted *total responsibility* for the planning and engineering of this processing line drive at the request of the mill . . . with logical and practical results.

Reliance is ready and able to produce similar results for you. Your Reliance Systems Engineer can tell you even more about the advantages which can accrue to you through Reliance's Total Responsibility and Total Service. Call him —through your nearest Reliance office—or if you prefer, write us direct.

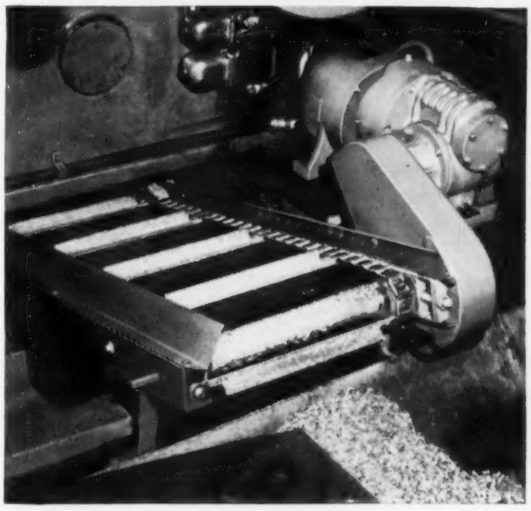
A-1687

RELIANCE...
builders of the tools of automation

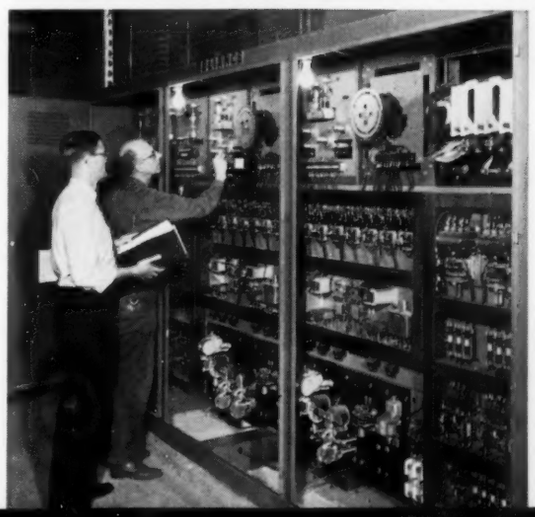
NEW DUTY MASTER D-5000 design brings you new standards in coolness, quietness . . . and more horsepower in less space. Frame dimensions that held 150 hp. now contain 300 hp. There is better heat dissipation from the frame itself. Air flows easily through the entire grilled end areas—exhausts through long, protected slots at the sides and bottom. New fingerless ducted rotor design means better cooling than any other previous motor. You get all famous Duty Master features in this new D-5000 . . . special lubrication design, drip or splash-proof and complete open motor protection. Bulletin B-2515.



RELIANCE V★S STATATRON is a static powered drive for wide range variable speed from in-plant a-c. circuits, available from 1 to 200 hp. Instead of a motor-generator set, the Statatron uses silicon diodes and saturable reactors to rectify the current from a-c. to d-c. These work in combination with a transistorized power exciter to supply variable voltage. Statatron is compact—35% smaller than conventional units. Consists of only three components: Super 'T' d-c. motor, operator's station and control cabinet. Statatron is quiet—vibrationless and low in maintenance cost. Bulletin D-2508.



THIS MASTER GEARMOTOR drives a chip conveyor on automatic screw machine. The combination parallel and right angle reduction produces efficient low output speed at high torque—ideally suited to this operation. Features important here are its compactness and one piece construction, saving space and maintenance. This Master Gearmotor is impervious to liquids . . . splashing of coolant and any other outside contamination. Where the situation calls for gearmotors, this full line can cut your engineering and assembly costs . . . give you dependable performance. Bulletin E-2409.

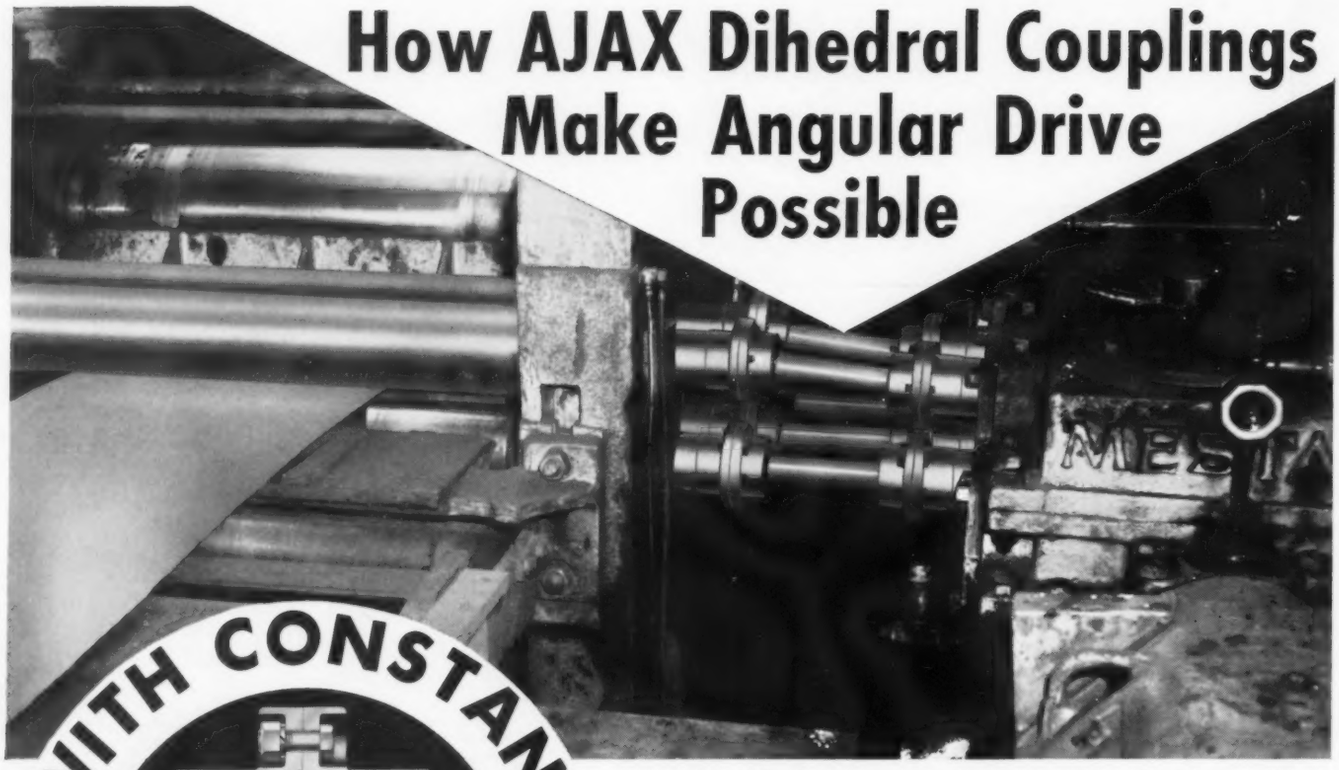


TOTAL SERVICE is an integral part of every Reliance product, from engineering and start-up assistance to maintenance and renewal parts. The photo shown here is typical of a Reliance Service Engineer's on-the-job availability—for maintenance and consultation on knotty problems. Every Reliance Sales Engineering Office and Distribution Center—nationwide—gives you the attention and experience necessary to assure the top performance you expect from the Reliance equipment you buy.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 11-6 CLEVELAND 17, OHIO • Canadian Division: Toronto, Ont.

How AJAX Dihedral Couplings Make Angular Drive Possible



5 AJAX Dihedral Floating Shaft Assemblies Driving Rolls of High Speed Straightener.

WITH CONSTANT PERIPHERAL SPEEDS

Cut-away section of standard AJAX Dihedral Coupling showing tooth design, lubricant seals and relationship of working parts.

The inherent ability of AJAX Dihedral couplings to transmit power at an angle and at the same time operate at constant peripheral speeds has been welcomed by machine designers. This has made it possible to improve performance of machines and at the same time secure greatly improved quality of products.

A dramatic example is in their many applications on rolling mills where they have demonstrated their ability to greatly increase operating speeds and produce new uniformity of gauge thickness and smoother surface finish.

They operate at constant angular velocity regardless of angle of misalignment.

They meet conditions where angle of alignment varies due to operating conditions involving adjustment of working components.

AJAX Dihedral Couplings are made in a wide range of special and standard types. For engineering consultation on your requirements, call the AJAX sales representative listed in the yellow pages or write us direct.

AJAX

AJAX FLEXIBLE COUPLING CO., INC.

20 PORTAGE ROAD WESTFIELD, NEW YORK

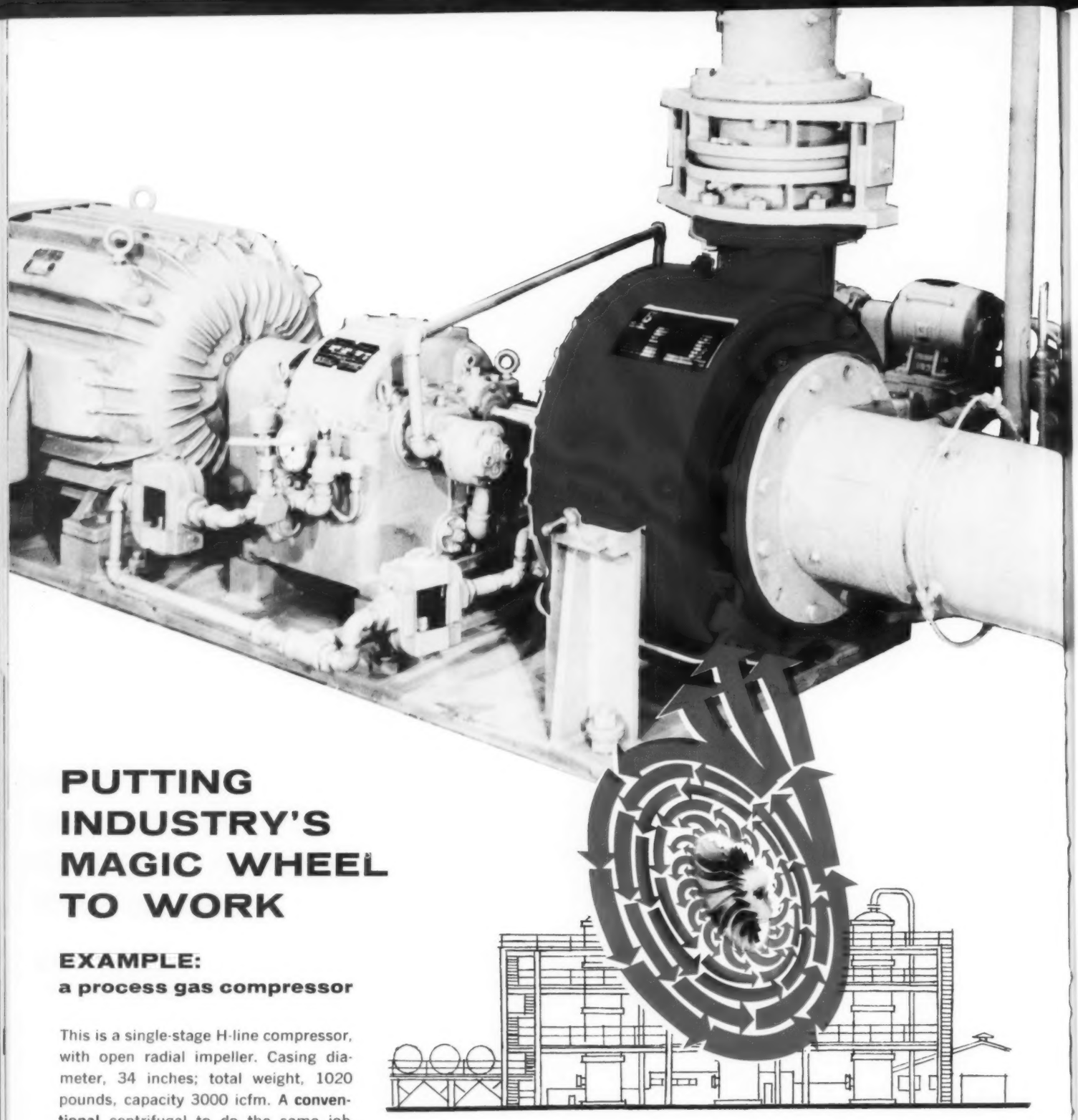
Incorporated 1920

In Canada — The Alexander Fleck Ltd., Ottawa

INDUSTRY'S MAGIC WHEEL

This is an open radial impeller . . . the heart of the Elliott H-line centrifugal compressor. The H-line compressor will ■ do more work ■ handle more gases ■ serve more applications than any conventional design. It permits dramatic reduction in compressor size and weight, facilitates Iso-cooling, and extends the advantages of **centrifugal** compressors into entirely new fields of application.

ELLIOTT
Company



PUTTING INDUSTRY'S MAGIC WHEEL TO WORK

EXAMPLE:
a process gas compressor

This is a single-stage H-line compressor, with open radial impeller. Casing diameter, 34 inches; total weight, 1020 pounds, capacity 3000 icfm. A **conventional** centrifugal to do the same job would be a 3-stage unit weighing about 9000 pounds.

Because corrosive gases will be handled, outer casing and all internal parts are made of stainless steels. This is economically feasible with Elliott H-line compressors due to their extremely small size and resulting light weight.

The one-piece, radial-bladed impeller has no cover or shroud member to create bending and hoop stresses.

Elliott H-line compressors include a wide variety of sizes and capacities, from 300 to 40,000 icfm.

The dependability of these compressors is proved by many years of operating experience with thousands of Elliott machines of similar design.

For specific information, call your Elliott district office, or write Compressor Department, Elliott Company, Jeannette, Pennsylvania.

ELLIOTT THE MOST COMPLETE LINE OF **INTEGRATED COMPRESSOR & DRIVER UNITS** 500 cfm to 600,000 cfm

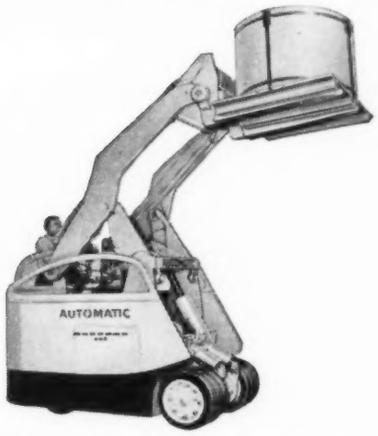
ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PA. PLANTS AT: Jeannette and Ridgway, Pa., Springfield, Ohio

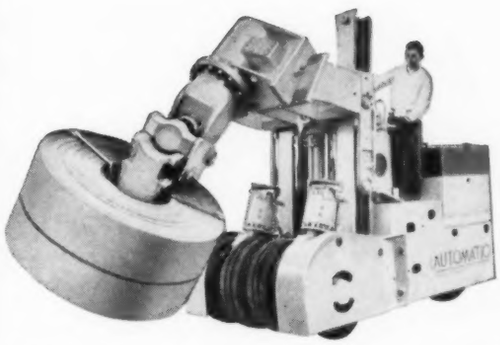
TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS • EJECTORS • STRAINERS • TUBE CLEANERS

P1-1

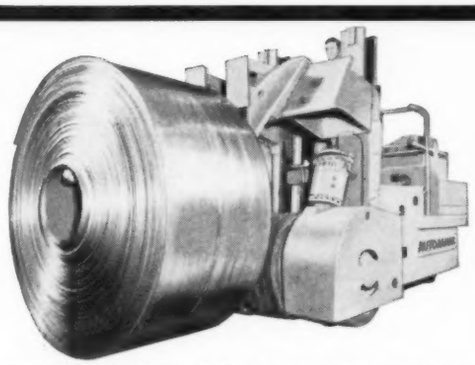
LOWEST COST WAY TO HANDLE COILED STEEL



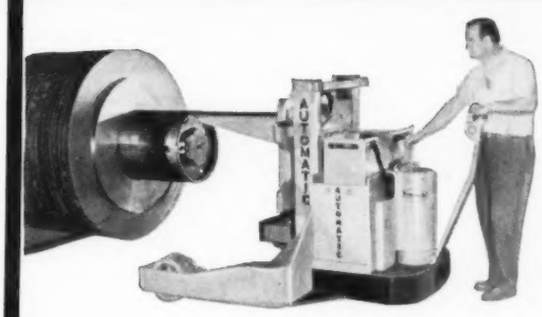
Exclusive Elbolift is most compact, most maneuverable heavy duty truck in its capacity range of 12,000 to 25,000 lbs. Loads coils in boxcars, positions coils on flat-bed trucks in one operation, stacks 120" high.



It's a mobile coil up-ender! Unique wrist-action rotating up-ender and clamp picks up horizontal or vertical coils and rotates them to opposite position. Clamp prevents telescoping. Capacity to 60,000 lbs.



Heavy Duty Giant is available in capacities from 20,000 to 100,000 lbs. This capacity range permits strip mills to roll larger, heavier coils to boost production and lower costs.



Heavy Duty Transporter with coil handling ram is ideal for jobs which involve close quarters, short distances, and intermittent use. Capacity to 20,000 lbs. in pallet, platform, fork or ram models.

AUTOMATIC®

HEAVY DUTY TRUCKS

IN CAPACITIES TO 100,000 LBS.

No other handling equipment gives you the mobility and flexibility of heavy duty lift trucks. You can handle loads anywhere in the plant—even into boxcars—without transferring the load to other equipment. With a lift truck, handling usually is a one-man job. What's more, lift trucks adapt easily to production changes.

Automatic brings you all of these advantages with trucks designed specifically to handle coiled steel weighing up to 100,000 lbs. There are models with hydraulically-adjustable rams, fork lift models for palletized coils, high lift coil stackers and walkie models for intermittent use over short distances. A new bulletin tells how heavy trucks can be profitably used in the steel industry.

Write for your free copy of Heavy Duty Trucks Facts and Factors today.

AUTOMATIC AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Co.
47 W. 87th Street, Dept H-1, Chicago 20, Illinois

Injection tuyeres contribute to improved blast-furnace performance

NBD reports on tuyere designs that simplify gas injection

Extensive research by iron producers the world over has firmly established the benefits of fuel and steam injection: higher blast temperatures, reduced coke requirements, increased tonnage and lower iron costs. And the tuyere, for decades a vital part of the blast furnace, is now assuming the additional function of an injection device.

Cooperating with blast-furnace operators, NBD product engineers are contributing to successful, simplified injection practices. An example is the sectioned tuyere pictured here which offers these distinct advantages:

1. The injection-tube feature may be incorporated in the basic tuyere design used in any furnace, whether the tuyere is a Standard, Angle Flow, Weir, Tennessee, or other design.

2. It serves a dual purpose in that it may be used in all tuyere locations in the furnace—and operated at will, with or without gas injection. Tuyere inventories are held to a minimum.

3. No expensive special equipment, such as lances or redesigned blow pipes and coolers, is required—just simple piping.

4. No exposed lances, nozzles or pipes, subject to damage by slag or metal splash.

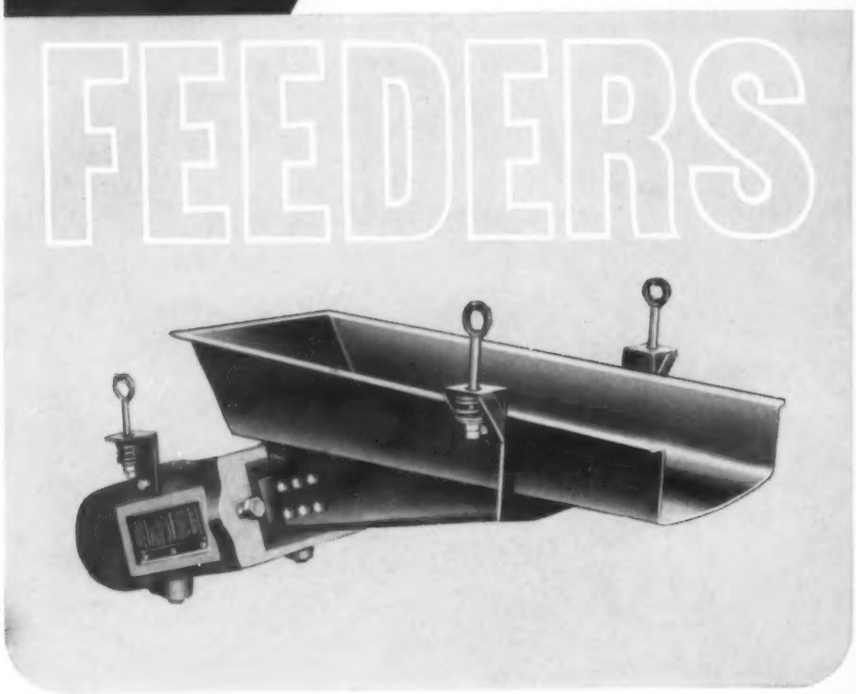
An NBD sales engineer is prepared to give you more information specific to your application. Call him or write us.

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
717-O Grant Building • Pittsburgh 19, Pennsylvania
PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PENNA.

REDUCE BULK MATERIALS HANDLING COST

SYNTRON VIBRATORY FEEDERS



EFFICIENCY, DEPENDABILITY
HIGH CAPACITY, LOW MAINTENANCE

More and more basic steel plants are specifying Syntron Vibratory Feeders as an integral part of their vast production system for low-cost, dependable bulk materials handling between storage and process equipment or process to process equipment.

Syntron Vibratory Feeders combine high speed (3600 vibrations per minute), efficiency, dependability, accuracy and high ton per hour capacity; variable control of amplitude provides a fully adjustable high-low feed rate cycle from torrent to dribble. Manual or automatic control.

Simplified electromagnetic drive eliminates all moving wearing parts—gears, belts, pulleys, etc., lowering maintenance costs.

Available with above or below deck drive —floor or suspension mounting—flat pan or tubular type troughs.

Feeders to meet every tonnage requirement.

Write for Syntron Catalog #605 and the name of the Syntron Representative nearest you.

61F3

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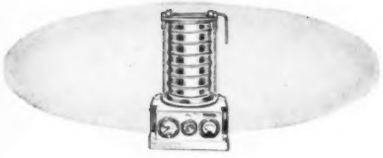
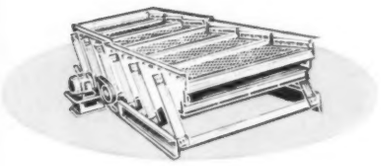
Other SYNTRON *equipment of proven dependable quality*



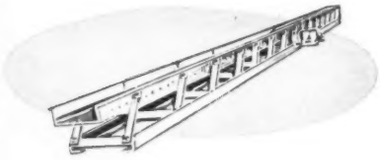
Test Sieve Shakers



Mechanical Vibrating Conveyor Screens

Roll Neck Seals

Rectifier Power Units



Mechanical Vibrating Conveyors

SYNTRON

SYNTRON COMPANY
699 Lexington Avenue • Homer City, Pa.

"For workability . . .

nothing matches Plibrico Spray-Tite"

. . . reports Patcher Foreman
of large coke plant:

"We are using Plibrico Spray-Tite for patching our batteries with excellent success. No other refractory mix does so complete a job."

"We gun our oven jambs with Spray-Tite and have very little rebound. We're trowelling, too, on hot walls and this material stays workable. It doesn't back up on the trowel either."

Plibrico Spray-Tite is ideal for making repairs economically without service interruptions. Use it with wet mix or nozzle mix guns, or trowel it. It bonds well, and withstands abrasion and shock. It's one of a complete line of Plibrico refractory products.

Plibrico Spray-Tite can be gunned in place with low rebound loss. Or trowel it in place; it's highly workable.

Recommended for: **Coke oven walls, jambs, charging holes Regenerator faces • Uptake pipe seals.**

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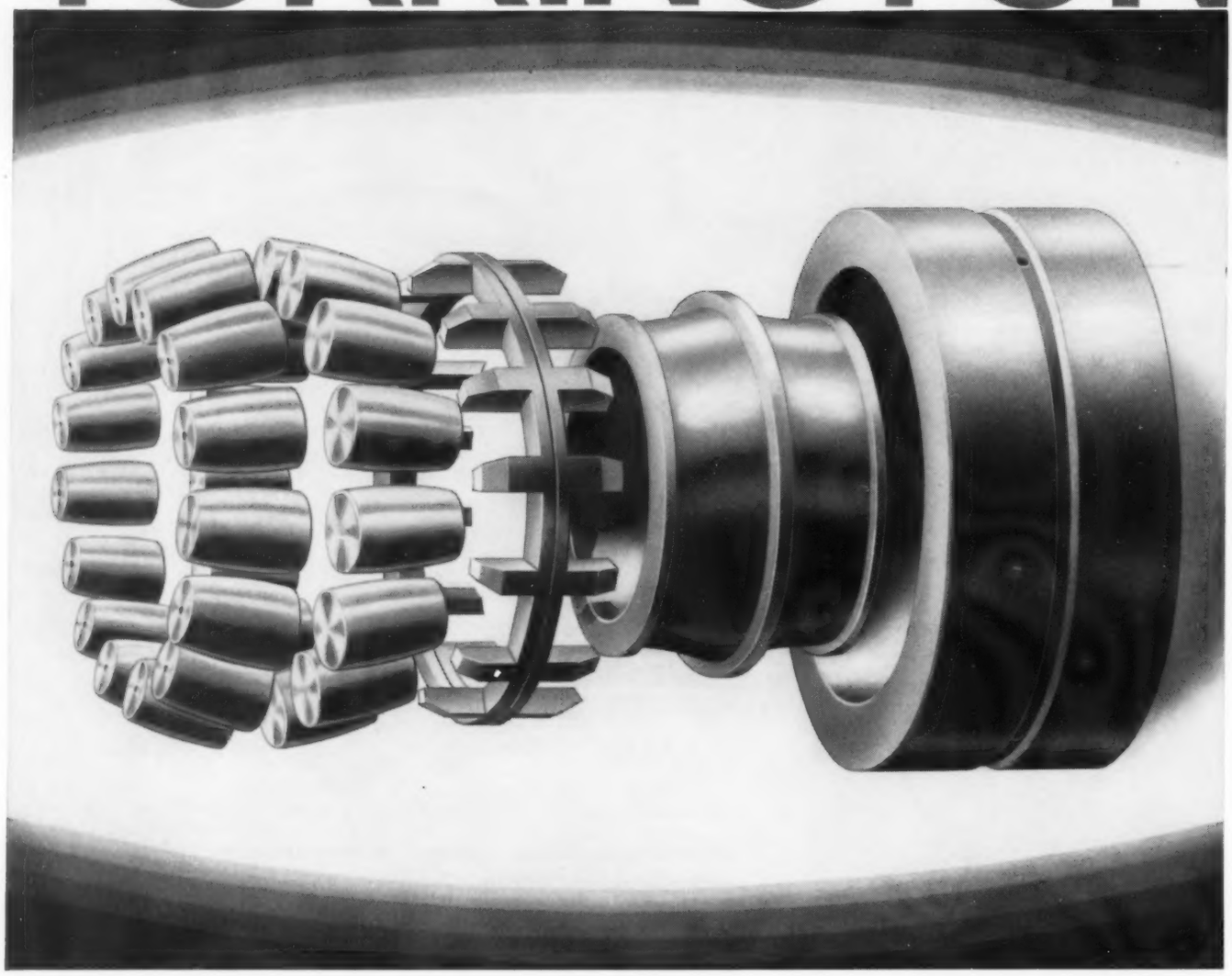
Sales and Service Throughout the World

WRITE TODAY FOR LABORATORY REPORT 900-A giving complete data on properties and advantages of Plibrico Spray-Tite.

TORRINGTON



FOR THE INSIDE STORY...

...ON TORRINGTON SPHERICAL ROLLER BEARINGS, one word: *precision*. Each individual part is precision-engineered to the highest standards in the industry... functions precisely and efficiently with all other parts.

Every roller is matched electronically within .0001" for even-load distribution and maximum capacity.

Each independent land-riding cage spaces rollers precisely... prevents roller drag even under the heaviest loads and possible misalignment.

The integral guide flange is ground to a common spherical radius with the roller ends for positive roller guidance, greater stability.

For minimum friction and wear, both inner and outer races are precision ground to conform exactly to roller contours.

Put together... a Torrington Spherical Roller Bearing for superior performance, reliability and long service life. Buy the best...specify Torrington.

SUPERIOR PERFORMANCE FEATURES OF TORRINGTON SPHERICAL ROLLER BEARINGS

- ☐ inherent self-alignment
- ☐ conformity of rollers to raceways
- ☐ integral center guide flange for stability
- ☐ positive roller guidance
- ☐ land-riding bronze cages
- ☐ maximum radial and thrust capacity
- ☐ controlled internal clearance
- ☐ electronically selected rollers
- ☐ even load distribution
- ☐ long, dependable service life

progress through precision

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THE TORRINGTON COMPANY

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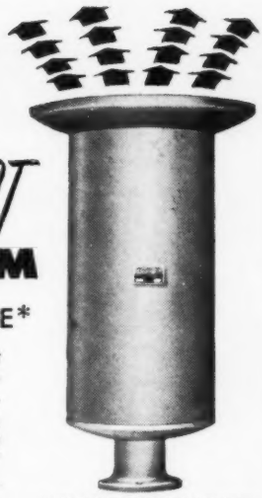

that noisy *EXHAUST*

AIR-GAS-STEAM

PULSCO BLOWDOWN MUTE*

Eliminate ear splitting fatiguing plant noise from exhaust vents with patented PULSCO Blowdown Mutes. Capacity: From 1,500 to 500,000 cfm air and gas. 3,000 to 1,000,000 lb/hr steam. Temperatures to 1,200° F. Overall sound pressure level reduced to 80 - 86 decibels at 100 ft. Excellent silencing plus separating and collecting condensate. Drain provided.

PULSCO MULTIPLE TUBE BLOWDOWN MUTE WITH REPLACEABLE TUBE BUNDLE

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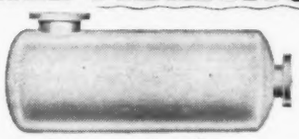
KILL VIBRATION with PULSCO



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Eliminates meter error.
Extends valve life.
For all types of rotary, reciprocating and plunger pumps.

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INDUSTRIAL FURNACES, Vol. I
FIFTH EDITION

By W. Trinks, *Consulting Engineer, and* M. Mawhinney, *Consulting Engineer*

This new edition of the internationally known book has been revised to a great extent. Added: method of calculation of heat transfer within a furnace enclosure; capacity of forced-convection-type furnaces; capacity of axial heating furnaces; charts on adiabatic flame temperatures; new types of furnaces. Illustrations have been modernized and charts revised to conform to experience obtained from existing furnaces.

The book answers three basic questions: how to design, build, and get trouble-free operation from a furnace that meets given specifications. A number of examples are included, illustrating methods of calculating furnace capacity, fuel economy, distribution of gases, and other problems related to furnace design. *1961. 486 pages. $17.00*

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. . . result in more efficient use of your capital equipment

Efficiency, production and profit can all be increased by air conditioning crane cabs and operators' pulpits. However, it takes a very special air conditioner to do the job dependably in spite of high temperatures, dirt and vibration.

More than 2500 Lintern Air Conditioners are in daily use on virtually every type of crane and pulpit operation in steel, aluminum, copper and other industries throughout the world.

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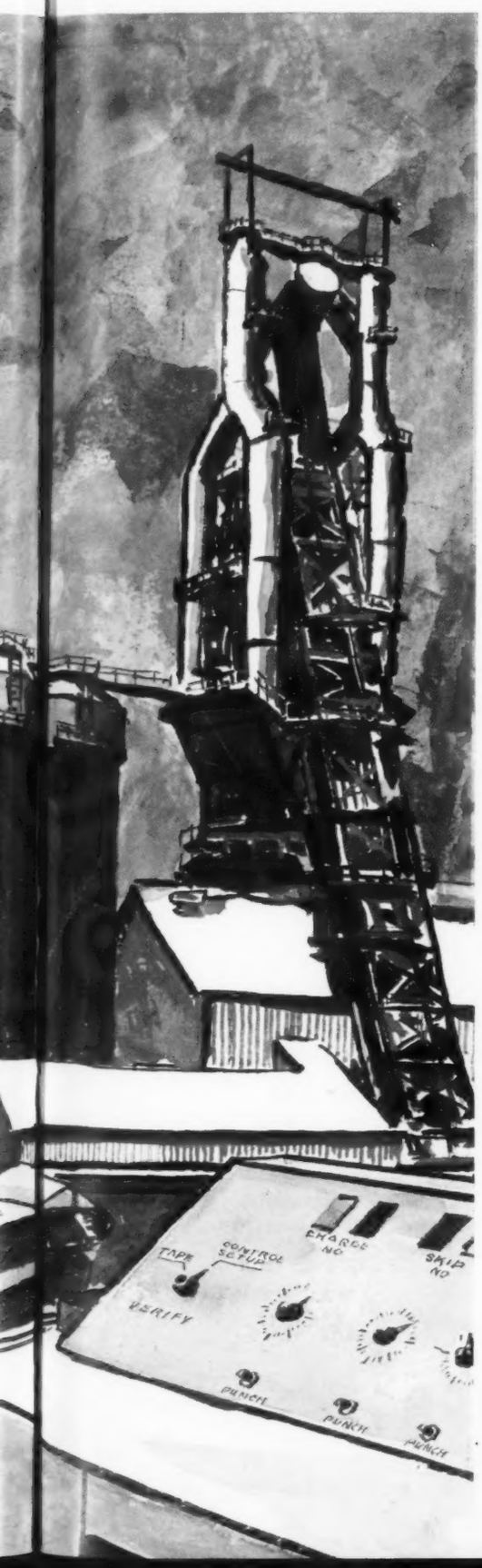
FOR QUALITY... PRODUCTIVITY ... PROFIT

BLAST FURNACES
AUTOMATED BY GENERAL ELECTRIC

Take "guesswork" out with General Electric

of charging; get increased iron output automated blast-furnace control system



Charge your blast furnace with exact amounts of materials in proper sequence at the desired time with new General Electric control. G.E.'s blast-furnace control automatically charges ore, coke, and stone on demand from the furnace according to predetermined selections set into the operator's control panel. Accuracy of this control permits 100 percent utilization of charging equipment for extended periods. You operate equipment with only the necessary capacity to supply desired furnace output. There's no need for extra capacity to compensate for operator fatigue or inability to meet furnace requirements with manual operation of the complex stockhouse. You increase furnace output with less investment.

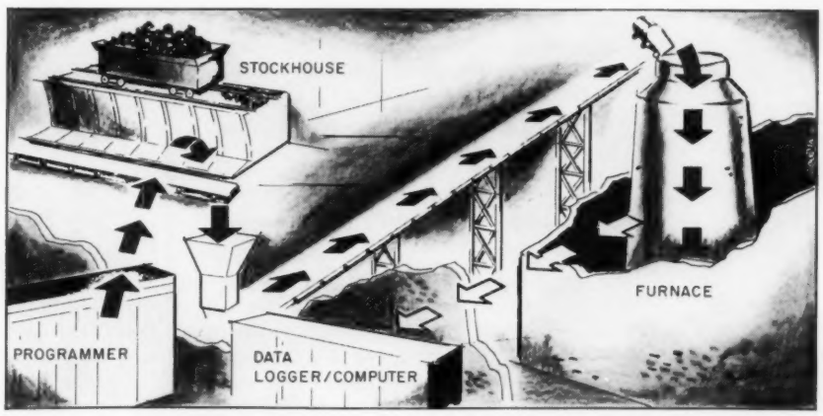
The entire charging operation is sequenced and interlocked to maintain desired furnace output, from material selection in the stock bins to the time the iron is tapped. To obtain desired iron quality, the operator selects only the necessary transfer switches, pushbuttons, and dials for sequence, type and amount of materials. The automated control takes it from there. General Electric's *DIRECTO-MATIC** control is the "mind" of the system, activating every charging step in proper sequence. Indicating lights on the panel keep the operator informed of every phase.

This new charging system reflects General Electric's continued control leadership for the steel industry for over 75 years. Let your General Electric sales representative work with you in automating your blast furnace, or in planning complete electrical systems for any process control. Or, write Section 785-18, General Electric Co., Schenectady 5, N. Y. *Industry Control Dept., Salem, Va.*

* Trade-mark of General Electric Company.

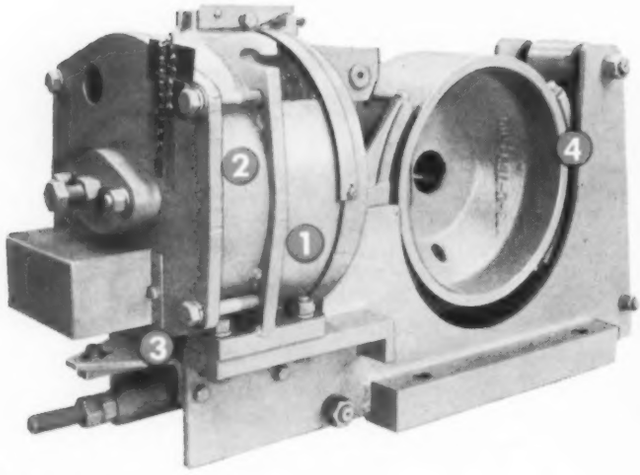
Progress Is Our Most Important Product

GENERAL ELECTRIC



A DATA LOGGER/COMPUTER, added to General Electric's charging control, can accumulate feedback on temperatures, pressures, and chemical analyses of burden during operation (white arrows). Following laboratory study, furnace operations based on this data can be set into the computer and the simulated results typed out. If the computer indicates desired output, the operation can be set into the programmer and experimentally run through the furnace (black arrows). Ultimately, the data logger/computer and programmer can be connected for complete automatic control of the entire furnace operation.

MILL-DUTY ACCESSORIES



DC BRAKES

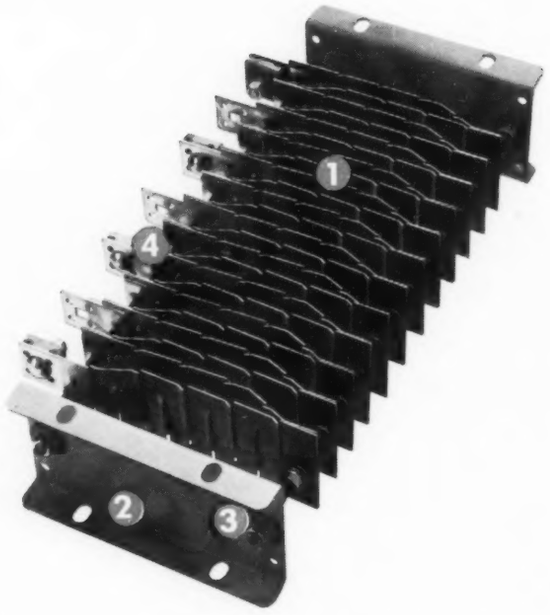
Single-end adjustment speeds maintenance and installation

New General Electric d-c brakes — featuring single-end shoe adjustment — are designed for easy maintenance and versatile installation. And, compensation for lining wear requires simple adjustment from only one end of the brake!

Here are more new features which make General Electric d-c magnet brakes your best buy for dependable, low-maintenance service:

1. **New magnet housing design** permits vertical removal, easy interchange.
2. **New coil** features all high temp. insulating materials potted in epoxy making brake ideal for the most rugged jobs.
3. **New pivot arm** assures equal shoe braking pressure.
4. **Easy lining replacement** does not require removal of brake shoe assembly . . . just lining.

Want details? See your G-E Apparatus Sales Engineer. Or, write Sect. 784-27, General Electric Co., Schenectady, N. Y., for Bulletin GEA-7067. *Industry Control Dept., Salem, Virginia.*



PUNCHED GRID RESISTORS

Designed for fast, low-cost installation

A combination of unique features makes corrosion-resistant, non-breakable, and all-welded General Electric punched-steel grid resistors easier, faster, and less costly to install. Key features are:

1. **Unique grid paralleling** saves time and expense since all parallel connections are made at factory. Grids come either series or parallel.
2. **Draw-out construction** speeds mounting in frame, assures positive alignment. Boxes are readily removed without disturbing those in place.
3. **Clip-lock and carriage-bolt fastener**— special device on runner guides locks box securely in frame. Front is bolted with only 2 self-holding bolts.
4. **All-purpose terminals** accommodate bus or cables. Taps provide means for adjusting resistance values.

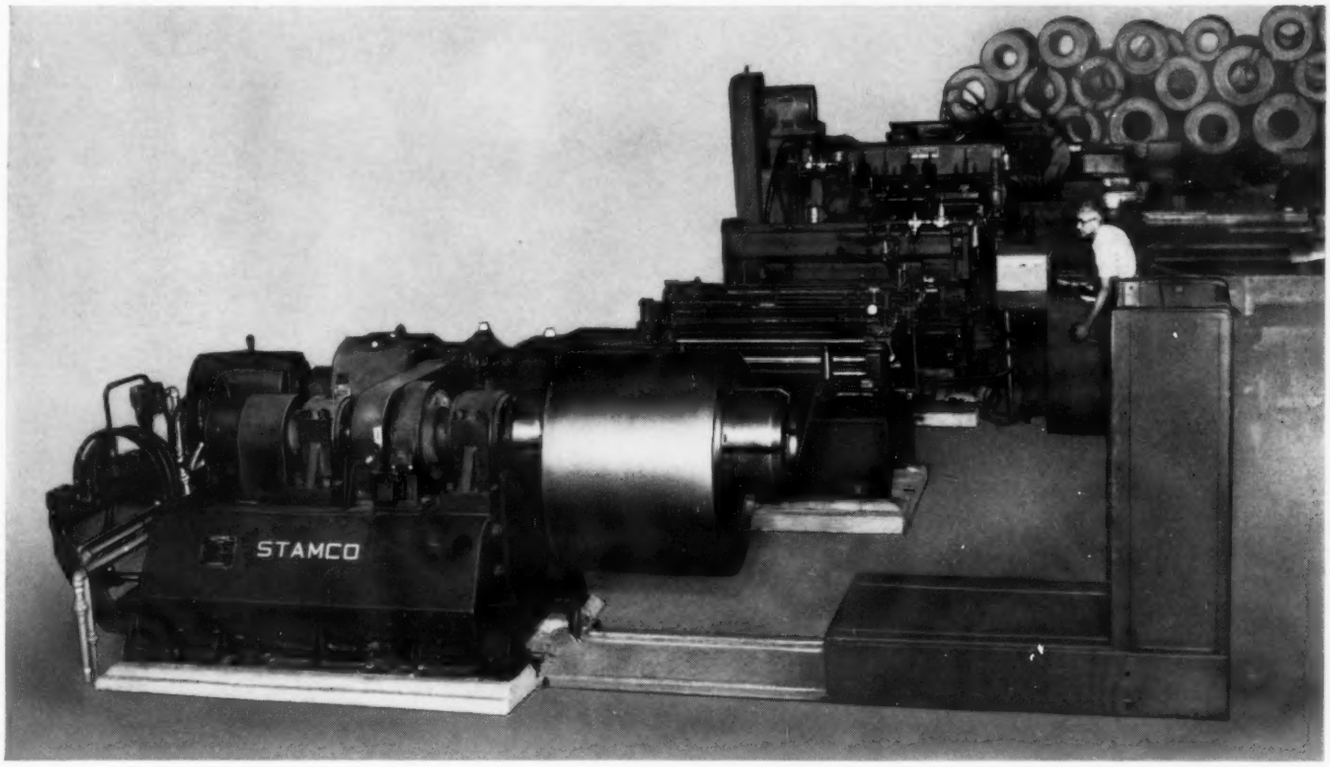
Like to know more? Contact your G-E Apparatus Sales Engineer, or write Sect. 784-27, General Electric Co., Schenectady, N. Y., for GEA-6858. *Industry Control Dept., Salem, Va.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

Stamco equipment

handles coils up to 72 inches wide . . . reduces operating costs



Designed and built for greater capacities, this new Stamco shear line will accommodate stock up to 14 gauge, in widths to 72 inches. It handles coils weighing a maximum of 20,000 pounds. Accuracy can be held to plus or minus 1/32 inch. Lengths can be cut from 14 inches minimum to any maximum length.

Stamco, Inc., New Bremen, Ohio, U.S.A.

Slitting and Coiling Lines • Cut-to-Length Lines • Flying Shear Lines • Power Squaring Shears • Continuous Process Lines
Ferrous and Non-ferrous Mill Equipment

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R. P. Popp, 101 Investment Building, Pittsburgh 22, Pa.
I. W. Spraitzar, 159 Main Street, Chatham, New Jersey
W. E. Heineman, 122 West Burlington Ave., LaGrange, Illinois
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GIANT LADLES
as large as ??? tons

(Above, left) World's largest iron charging ladles; 230-tons capacity, with new type scalene-cone nose for very rapid pouring into oxygen furnaces.

(Above) 350-ton capacity ladles, ready for shipment.

(Left) Center segment of 400-ton capacity ladle, leaving the PECor plant.

400 TONS—WE'VE BUILT FOURTEEN, THE WORLD'S LARGEST LADLES NOW IN SERVICE. **500 TONS**—WE HAVE DETAILED DRAWINGS AND COULD BEGIN PRODUCTION TOMORROW. ??? TONS—

Whatever your ladle requirement, PECor will add important plus features in design . . . and will deliver assured reliability—ladles notable for staying on-the-line and making steel.

May we discuss any phase of ladle design, fabrication or repair?

Pennsylvania Engineering CORPORATION NEW CASTLE, PA.

Sales Representatives: Wooldridge Company, Burlingame and Los Angeles, Calif.
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Licensees: Ashmore, Benson, Pease & Company, Ltd., Eng.
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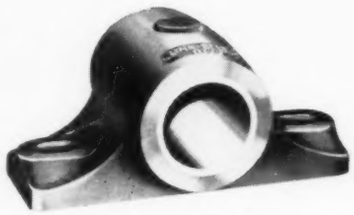
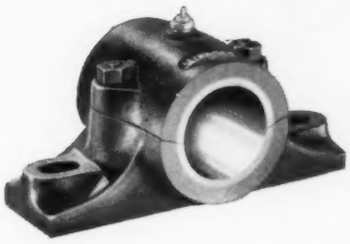
BUILDER OF AMERICA'S FIRST 15 OXYGEN CONVERTERS

Choose Link-Belt as your one-source headquarters for



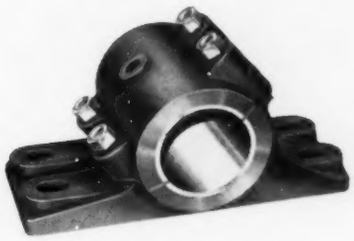
SOLID PILLOW BLOCKS

Gray iron housings, babbitted or bronze bearings—or plain bored bearings; for ½ to $2\frac{15}{16}$" shafts.



SPLIT PILLOW BLOCKS

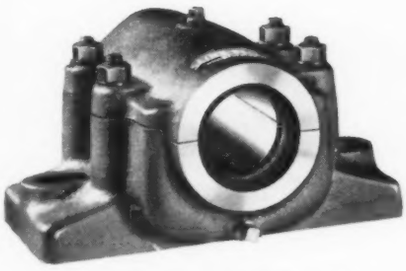
Split and split-gibbed types; gray iron or cast steel housings; bronze or babbitted; 2-bolt for ½ to 3" shafts; 4-bolt for $1\frac{15}{16}$ to 12" shafts.



ANGLE PILLOW BLOCKS

For heavy angular loads; split gray iron housings; babbitted or bronze bearings; 2-bolt for $1\frac{7}{16}$ to $2\frac{15}{16}$" shafts; 4-bolt for $1\frac{15}{16}$ to 9" shafts.

babbitted and bronze bearings

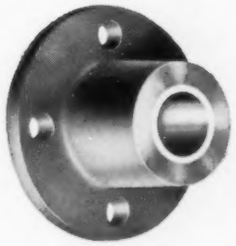


RING-OILING PILLOW BLOCKS

Split housings; babbitted bearings; self-lubricated; 2-bolt for $1\frac{3}{16}$ to $2\frac{15}{16}$" shafts; 4-bolt for $1\frac{11}{16}$" to $3\frac{15}{16}$" shafts.

FLEX-BLOCK SLEEVE BEARINGS

Self-aligning, self-lubricating, with sleeves to suit various operating conditions; pillow and flanged block types; for shafts from ⅝ to $3\frac{15}{16}$".



FLANGED BLOCKS

Solid gray iron housings; babbitted bearings; 4-, 6- or 8-bolt flanges with machine-finished faces; for $\frac{15}{16}$ to $5\frac{7}{16}$" shafts.

Over 15 types, more than 350 sizes . . . and all these features besides!

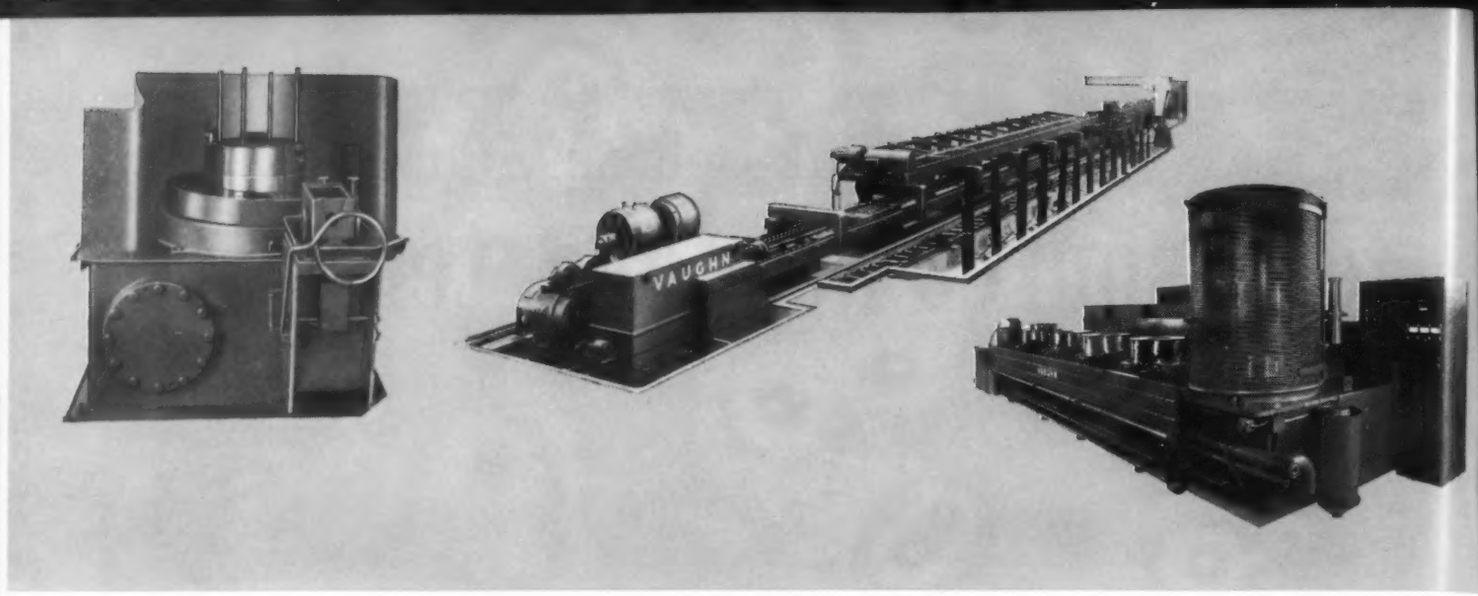
- **DURABLE, COMPACT HOUSINGS** of cast gray iron or cast steel provide exceptional strength where needed, without excess size or weight.
- **PRECISION-MACHINED BORES** provide correct running clearance between shaft and bearing metal for load carrying oil or grease film.
- **STURDY BEARINGS** of heavy-duty babbitt or high-quality bronze are anchored in housing.
- **ACCURATELY MACHINED BASES** assure firm seating on supports.
- **FINISHED ENDS** permit flush mounting of sprockets, pulleys, wheels and collars against bearings.
- **SHIMS** between cap and base of split housings provide shaft clearance adjustment, compensate for wear.
- **SLOTTED BOLT HOLES** in bases allow easy adjustment for shaft alignment.
- **RELIABLE LUBRICATION**—Holes for grease cups or pressure fittings are drilled and tapped. Grooves distribute lubricant over entire shaft surface. (Flex-Block and ring-oiling types are self-lubricating.)
- **OFF-THE-SHELF DELIVERY** is offered by Link-Belt on over 15 types and more than 350 sizes of babbitted and bronze bearing pillow and flanged blocks . . . for commercial shafting up to 12" diameter. Also immediate delivery on takeups in all popular sizes.

For complete information, contact your nearest Link-Belt office or authorized stock-carrying distributor. Look under BEARINGS in the yellow pages of your telephone book. Ask for Book 2707 and Folder 2823.

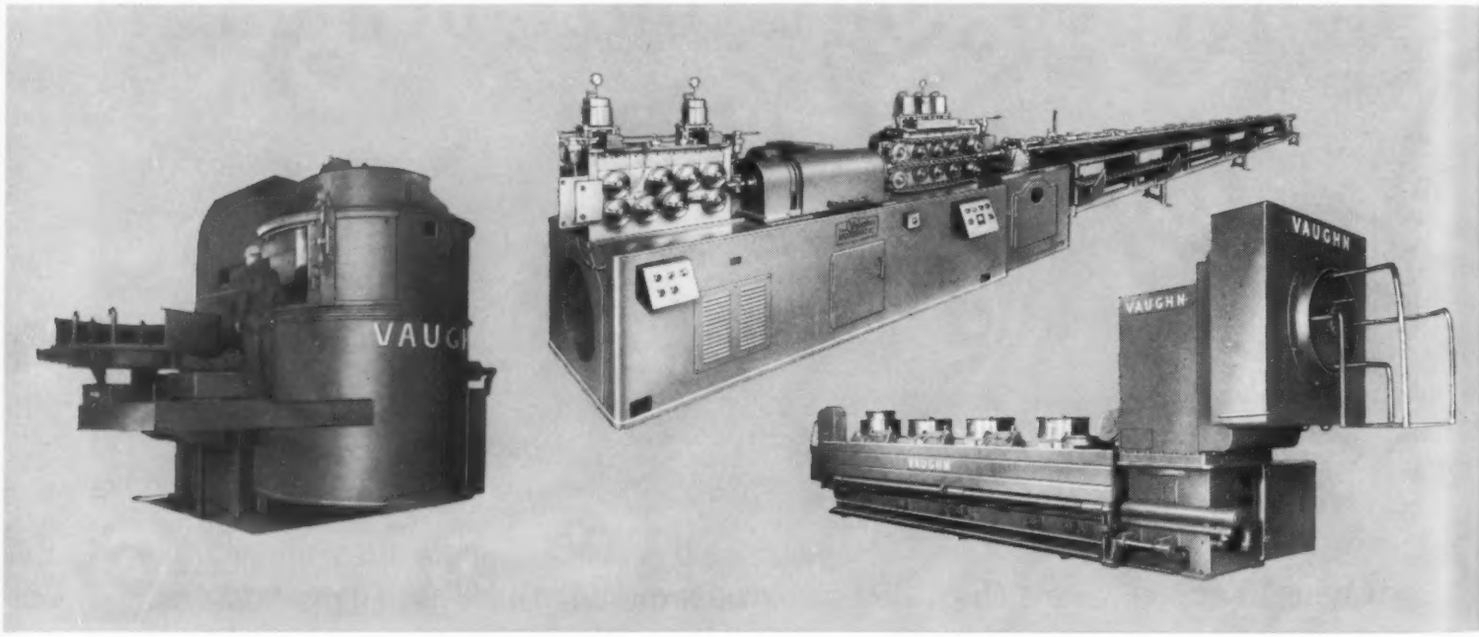
LINK-BELT

BABBITTED AND BRONZE BEARINGS

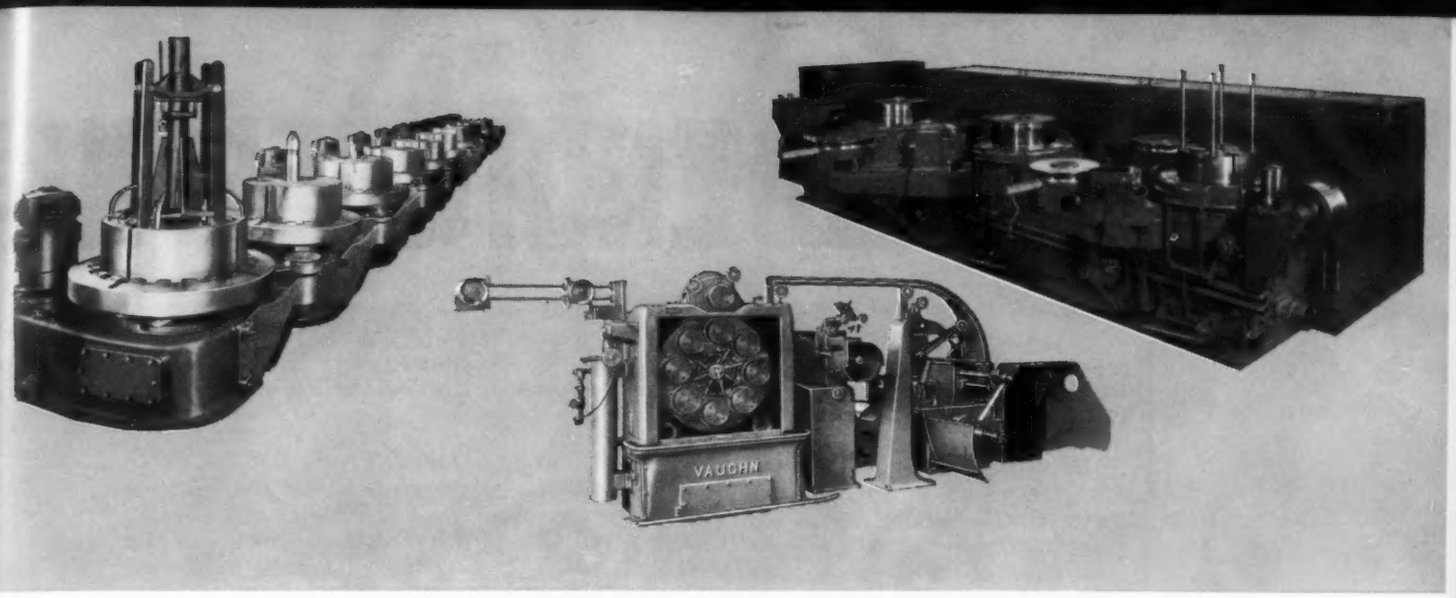
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World. 15,641



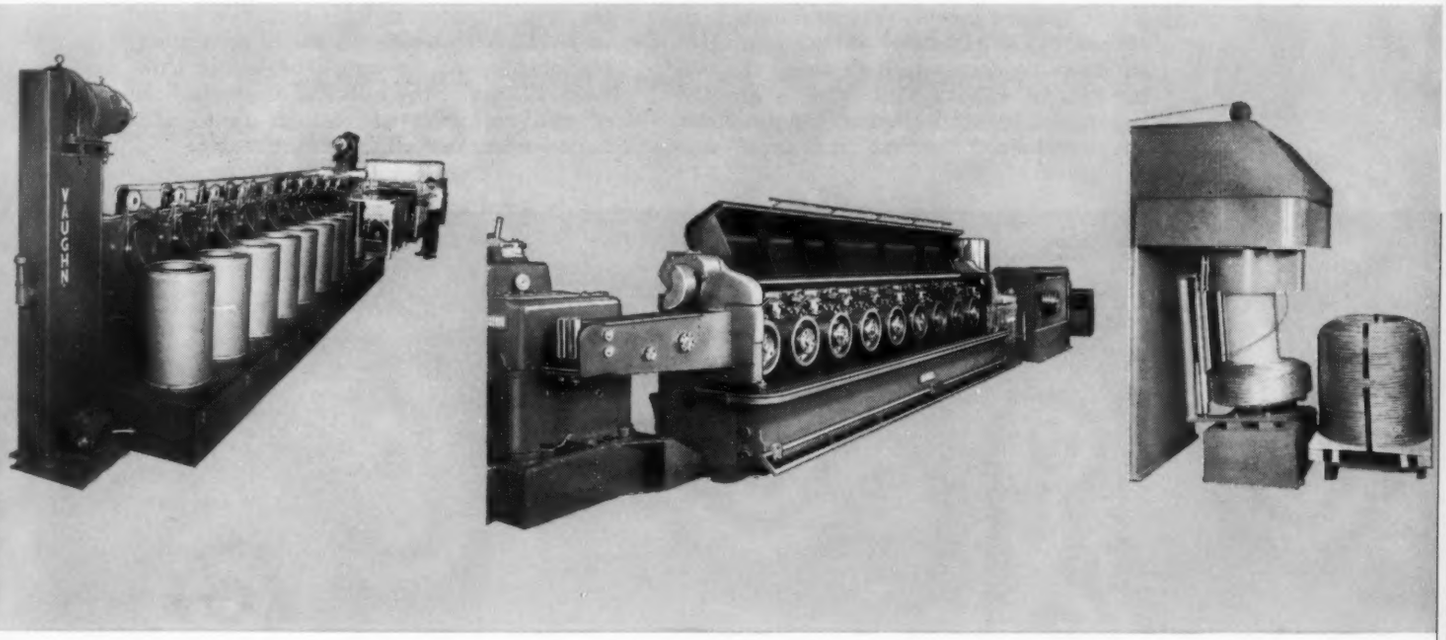
IF IT'S COLD DRAWN



The World's Most COMPLETE LINE of Cold Drawing Equipment ... for the Largest Bars and Tubes ... for the Smallest Wire ... Ferrous, Non-Ferrous Materials or their Alloys.



...SEE VAUGHN!



"Quick on the Draw!"

When cold drawing is part of your production picture, come to the leading equipment manufacturer for every service you may require . . . consultation, design, layout, quotations . . . and the broadest choice of cold drawing and related machinery in the world. You'll find Vaughn co-operation as complete as our resources. Let us serve you!

THE VAUGHN MACHINERY COMPANY

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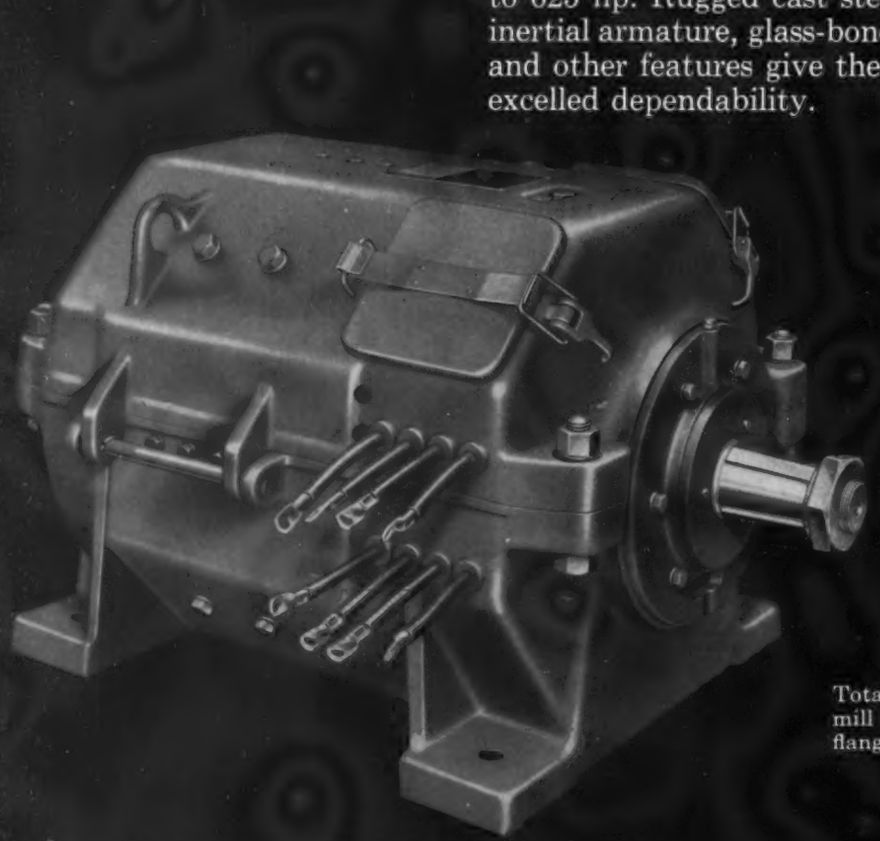
ADVANCED ENGINEERING P

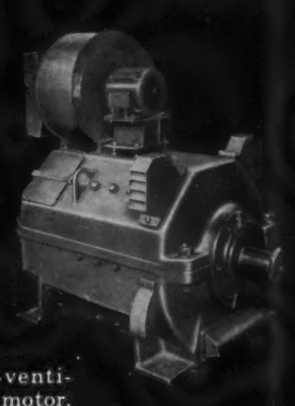
ELLIOTT

MILL MOTORS

Extra reserve power, fast response, high efficiency, great mechanical strength, time-saving accessibility—these characteristics of Elliott Mill Motors are the result of advanced engineering practices, developed since the first "mill type" motor was introduced by Crocker-Wheeler in 1904. With a fine record of continued leadership and accomplishment in this field, Elliott today offers a complete line of mill motors, with ratings up to 625 horsepower, for mill and crane service.

Elliott Mill Motors for heavy-duty mill and crane service are built in ratings up to 625 hp. Rugged cast steel frame, low-inertial armature, glass-bonded insulation and other features give these motors unexcelled dependability.





Protected force-ventilated form W600 motor.

Totally enclosed vertical mill auxiliary motor for flange mounting.

G PUTS EXTRA POWER IN

Low Losses. Electrical losses are minimized through the use of low-loss steel for the armature core, the laminated design of main poles and interpoles, and through superior commutation.

Effective Cooling. Internal air is circulated by integrally cast fan blades on rear coil support, conveying heat from commutator, armature core and field coils to the frame, where it is dissipated. Two concentric groups of air ducts within the armature core assure ample ventilation and effective cooling. This efficient method of heat dissipation permits higher motor output and provides greater reserve power for a given frame size.

Spark-Free Commutation. Tests up to 300 per cent load show negligible sparking. Generous brush area keeps current density at a conservative rating. Multiflex or split type brushes maintain proper contact with commutator. Brushholders are designed to permit top performance and to give high overload capacity. Accurately broached brush compartments assure free action of each brush. Deep commutator bars of silver-bearing copper provide extra wearing depth.

Glass-Bonded Insulation. Armature coils consist of double-glass-covered-wire, insulated from the core with silicone-bonded mica insulation, giving superior electrical and mechanical protection, and lasting resistance to high temperatures, moisture, mill dust and oil.

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

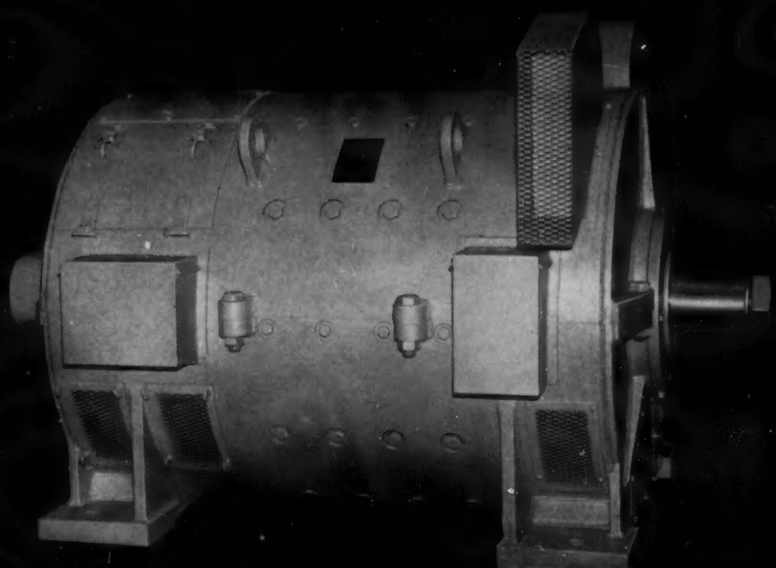
PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS
EJECTORS • STRAINERS • TUBE CLEANERS

W1-1

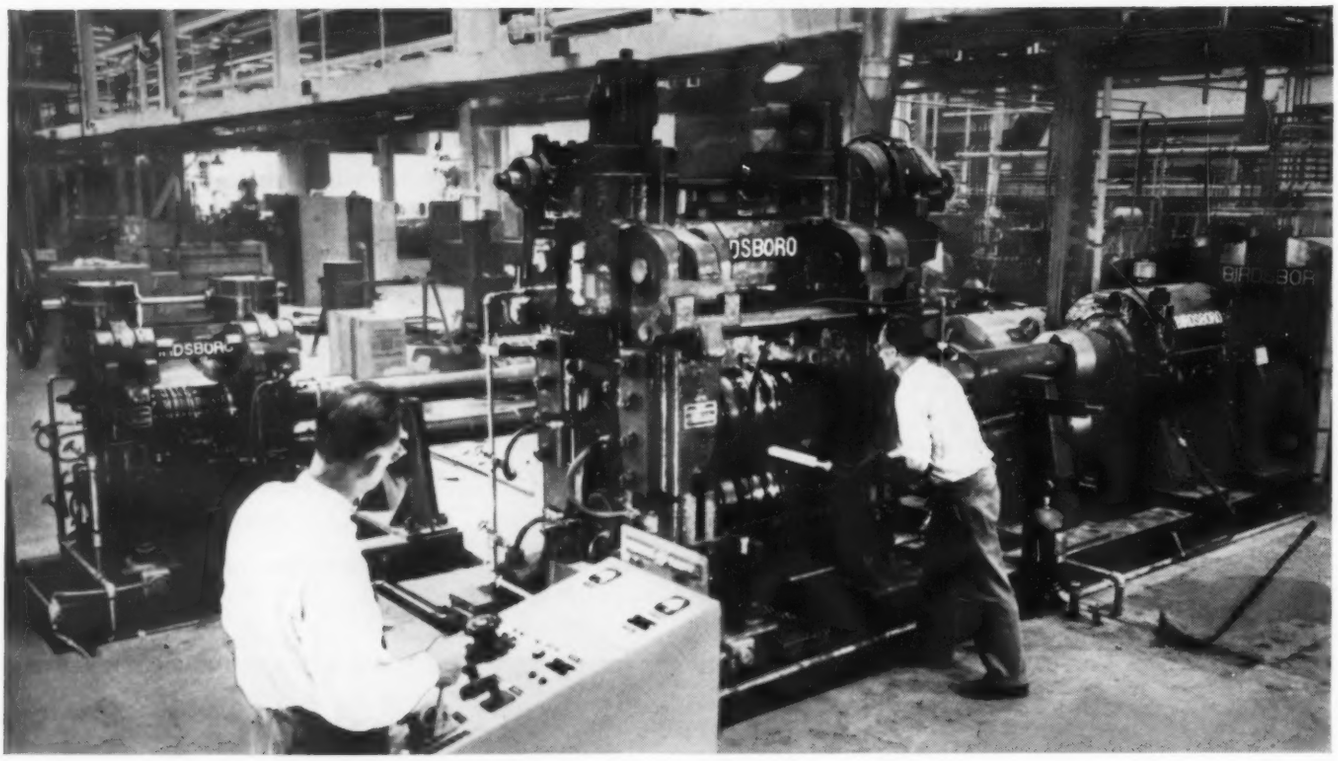
To meet the need for greater power, Elliott offers 620, 622 and 624 frame Mill Motors shown below. Built in ratings up to 625 hp, these motors have heavy fabricated split steel frames, low-inertia armatures, many easy-maintenance features.

The 620 frame motor in totally-enclosed, non-ventilated design.



The Elliott 622 frame Mill Motor with protected, self-ventilated enclosure.

New metals limber up for General Electric in BIRDSBORO experimental mill



To a manufacturer, today's miracle metals can be a dream come true . . . or a nightmare. General Electric finds out which—in advance—in this experimental laboratory. Here, scientists check out the unknown factors of these new metals by experimentation.

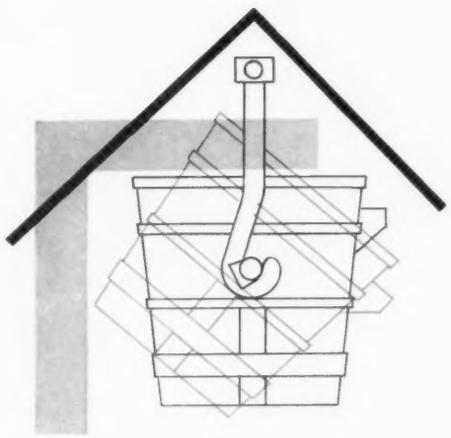
A laboratory feature is a Birdsboro 16"-10" bar mill. Custom designed to General Electric's specific requirements, it will help them explore new areas . . . and open new fields . . . in metals production. The Birdsboro men who designed and made this equipment are ready and willing to help you on your next mill machinery job. *Sales Department, Engineering Department and Mfg. Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

MM91-60

BIRDSBORO

CORPORATION BIRDSBORO, PENNA.

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • ROLLS • ELECTRIC STEEL CASTINGS: Carbon, Low Alloy and STAINLESS STEEL



STEEL ANGLES

SINCE the close of World War II, private industry has increased its expenditures for research and development approximately twelve fold. In 1945 some $990,000,000 were expended for this purpose, as compared with over $12,000,000,000 in 1960 and by 1970, the figure is expected to reach $27,000,000,000. The principal results of this outlay have been new and improved products and methods of manufacture. However, what is of great significance, and often overlooked, is the fact that the new products have provided an incentive for firms to expand and diversify their operations. As a consequence, companies have crossed old established industry lines and have entered into competition in other industries.

This development has added a new dimension to the concept of competition and concentration within an industry. We no longer can think of the oil companies making up the petroleum industry, or the chemical companies constituting the chemical industry, for they now compete with each other in the field of petrochemicals. Likewise, one of the largest chemical companies is now in the aluminum business.

Research and development have also resulted in the discovery, not only of new products, but of new uses and substitutes for established products. Thus, technology has increased the number and diversity of products for a particular purpose and has given the consumer greater flexibility of choice in fulfilling his needs. This has become increasingly evident in the construction field where brick and stone, once considered irreplaceable as material for building facades, now compete vigorously with stainless steel, aluminum and glass. The same is true in the container industry where paper, tin plate, glass and aluminum are among the products striving for the consumer's dollar.

These observations are elementary to those involved in competition for markets. However, as yet they have not completely penetrated the thinking of those who philosophize about concentration and competition in our economy. In many instances, the degree of competition in an industry is measured by the number of firms listed in an industrial category by the Census of Manufacturers, whereas in reality there are many firms from other industries competing for the same market. Thus, the prevalence of a relatively few firms in a given industrial category does not necessarily mean that competition is limited.

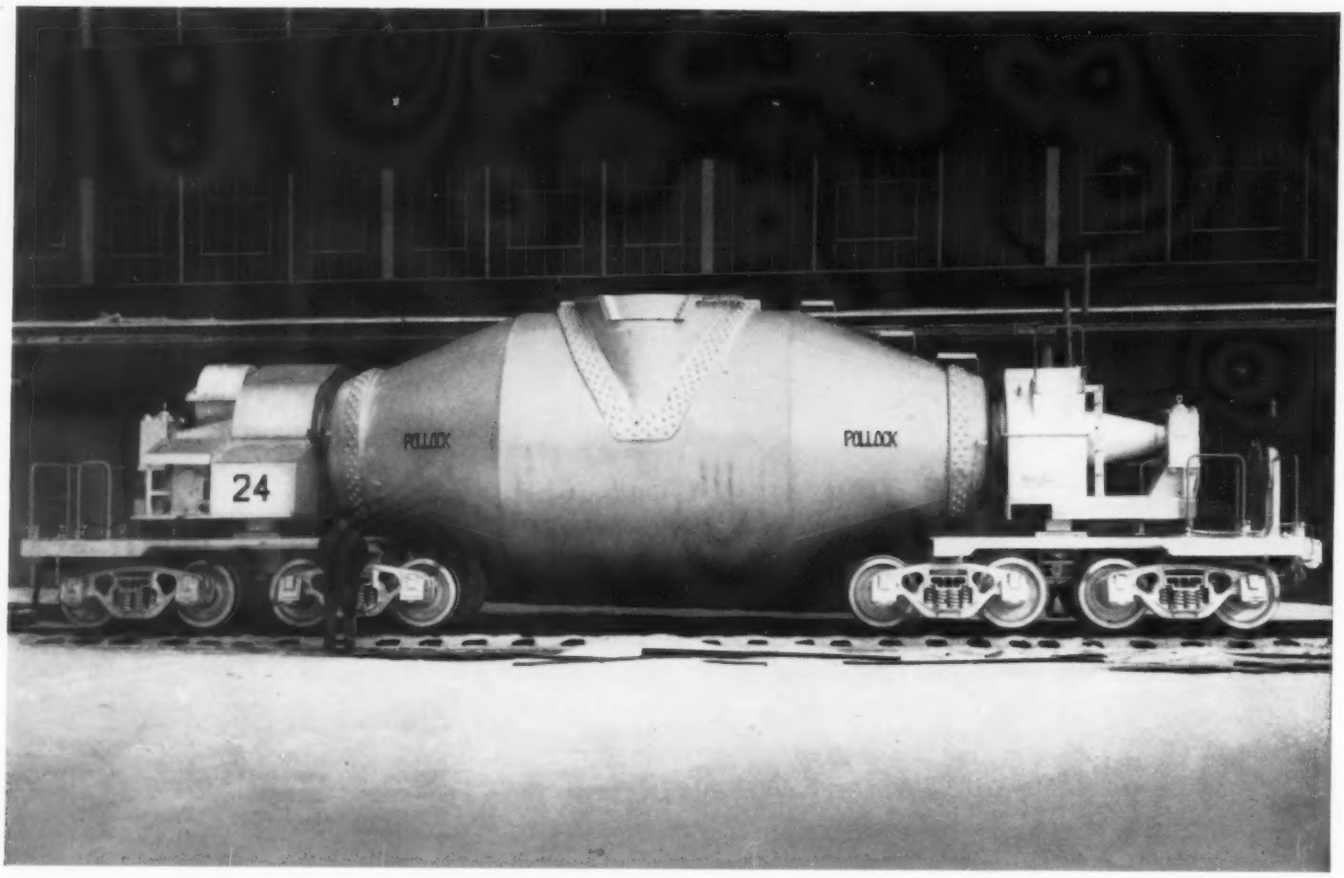
It is necessary to look, not at the producer, but the market and the number of producers in the various industries that supply that market if we are to have an adequate and realistic measure of competition. This type of inter-industry competition can be expected to grow to a much greater extent in the next few years as funds spent for research are expanded. Further, there are a number of companies that have reached out and left their traditional line of production in order to survive. This has been true in the "locomotive industry" and, to some extent, among the automobile manufacturers.

Since steel has found so many uses in our economy, it is only natural to expect ever increasing competition from other industries for the markets served by steel. Building facades and containers are but two instances; others include certain areas of the pipe and sheet markets which have been invaded by aluminum and plastics. This is not too extensive a development as yet, but could well become a formidable competitive force.

There is little doubt that steel will meet the competitive challenge, and in fact, has already done so with improved products and processes. New steels for construction which are lighter and stronger, as well as a special light weight tin plate are but two examples of the response to inter-industry competition. We can also look to steel to reach into new areas and replace other materials as it replaced wood and glass in the past.

Competition from outside the industry, as well as that from foreign steel producers, will be a spur to the steel industry in the years ahead. In the long run, it should produce economic good, as it has in the past. Healthy competition has always meant progress, for under its influence, in spite of some short run economic dislocations, the industry will thrive and grow, and the consumer will benefit. In the process, however, we can hope that this wider, broader concept of competition—competition for markets rather than just among producers—will become the accepted norm among those whose function it is to judge concentration and degrees of competition within industries. We can hope for a more dynamic definition of an industry, for with the tendency to diversify and the ability of companies to cross industry lines, one wonders if our present concept of an industry has not become obsolete. There are products, processes and producers, but in the exact sense of the term, there are few, if any, clearly defined industries today. The full recognition of this fact will introduce a greater note of realism into the thinking, not only of industrialists, but economists and legislators, as well. ▲

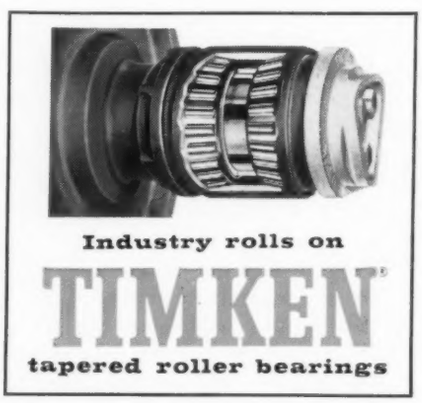
Hot car rolls on cool bearings—



Weighing a whopping total of 360 tons, this car transports 200 tons of hot metal from blast furnace to refining unit. To be sure of cool running wheel bearings to make the car roll easier, take the terrific loads and shock, the car manufacturer—The William B. Pollock Co.—specified Timken® heavy duty "All Purpose" tapered roller bearings, the type used on more and more of America's freight cars. Because Timken bearings *roll* the load they practically eliminate friction. Cars start and roll easier, saving power. And because of their tapered design Timken bearings take *both* radial and thrust loads. No auxiliary thrust collars are needed. Timken "AP" bearings come pre-assembled, pre-lubricated, ready to install. They will go 4 years without adding lubricant. Maintenance is reduced, car availability increased. By reducing friction, they cut locomotive wheel spinning, decrease wheel wear, eliminate flat spots on rails and increase rail life.

YOUR SAVINGS MOUNT when you use the services of our graduate engineer salesmen. They'll work with you at the design stage, can often solve your bearing problems *on the spot.*

GREATER BEARING ACCURACY is assured through super-sensitive gages in our master gage laboratory, one of industry's finest. Some instruments measure even the thickness of several molecules.



The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO." *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.* Canadian Division: Canadian Timken, St. Thomas, Ont.

the rolling of Ultra-Thin Tin Plate

Though ultra-thin tin plate can be produced by several methods, some of which utilize present facilities, existing equipment may not permit the most economical tonnage production.

THE subject matter of this article has to do with a phase of the manufacture of tin plate. The methods of production of tin plate, a tonnage product (having reached a U. S. figure of about 5,500,000 tons in 1957, and a world figure of 8,300,000 tons) are not such that they can be altered easily, for great investments of capital might have to be discarded in any contemplated changes. At the same time, and also because of the large productions involved, what might at first look like relatively small economic gains may actually amount to large total annual savings.

Perhaps the first major change in the production and rolling of tin plate in modern times was due to the introduction of the 4-high mill in the 1920's,[1]* initially for cold strip rolling and shortly thereafter in hot strip mills. Considerable doubt then existed among producers and users as to whether the cold reduced strip product, subsequently coil annealed and temper rolled, could match the then current properties of tin plate attained by rolling on 2-high hot and cold pack mills, including either an intermediate pack normalizing or a black annealing treatment plus a subsequent white annealing operation.[2] The present product is now accepted as quite superior to the earlier product, and is far more economically produced. This latter factor is one of primary importance in present discussions. By 1943, some 15 years after the introduction of the cold reduced tin-plate product, 100 per cent of the product in the U. S. was being produced by the new method.

Even with the general acceptance of the continuous cold reduction process, two major manufacturing steps were still carried out as batch or sheet operations: annealing and tinning. The conversion of both of these operations may be said to be major changes and steps forward in the production of better and cheaper tin plate. In the case of electrotinning pilot plant operations started some ten years after the beginnings of the cold reduction process. However, it took the economic pressures of World War II, to solidly launch the commercial continuous electrolytic process on its way toward supplanting the age old hot dip sheet process.[3, 4] Commercial production started in 1941, and by 1959, 93 per cent of all tin plate produced in the U. S. was electrolytic. Continuous annealing of tin plate had a somewhat earlier start than continuous electrotinning, having started as a captive operation around 1940.[5, 6] At the present time it is estimated that more than 50 per cent of all tin plate being produced in the U. S. is being continuously annealed.

The economic production of ultra-thin tin plate bids fair to become a fourth major modification in tin-plate manufacture. Although tin plate as a commercial product has ranged from 50 to 250 lb per base box (0.0056 to 0.0280 in.), the standard of commerce in the U. S. is 100 lb per base box (0.0113 in.), and in the United Kingdom 108 lb per base box (0.0122 in.). In recent

* Number in parentheses refers to Bibliography at end of article.

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times the average tin-plate gage produced has been around 80 lb per base box (0.0090 in.), reflecting a slow but steady downward trend from the standards established many decades ago. Now the industry is being confronted with the matter of producing at essentially half these gages in commercial quantities and at attractive prices. The range of gages that might properly be called ultra-thin are from 0.0060 to 0.0030 in., with a median of 0.0045 in. (40 lb per base box).

The present interest in these very light gages stems from many sources. The competitive situation in the container industry is ever quickening, with aluminum, glass and paper increasing their volume, and making inroads into the tin can field. The tin can industry is retaliating effectively in many lines and increasing its volume as well.[7] About 42,000,000,000 cans were used in the U. S. in 1959, 20 per cent were for canning beer. When it is realized that over 20,000,000,000 cans and bottles of beer were sold in America in the same year, the importance of this potential market to the tin-plate industry can be appreciated. And an even larger potential market, almost 50 per cent greater is the carbonated drink market, which awaits the tin can if it can be produced as an acceptable, low cost product. A start has already been made in this direction with more than 500,000,000 cans used in 1959 for this purpose and 750,000,000 anticipated for 1960. Still another large market is that of citrus juices, frozen or otherwise, which is also being strongly contended for by the aluminum can people. The objective in all these efforts is a less expensive can, adequate for the purpose, regardless of gage. Preliminary but serious thought has been given in the recent past to the problem of producing ultra-thin tin plate. Therefore, it was not too unexpected when Roger Blough, chairman of the board of the United States Steel Corp., at the annual convention of the National Canners Assn. in January, 1960, announced that his company was working on a "new tin plate which . . . will be lighter, thinner and stronger." Yet, there were voices that, while agreeing that such a product can be made, feared that it would be more expensive.

There may be some question as to whether this is a problem for the rolling mill builder. Perhaps this problem would better be left in the hands of the tin-plate producer. In either case, various possibilities in the furtherance of the objective of producing ultra-thin tin plate will be covered here with particular emphasis on its rolling.

The economic picture must first be studied. All figures used are primarily for comparison purposes. Although tin-plate prices are quoted in dollars per 100 lb, they have been recast into dollars per base box since this is a more proper index for this comparison. In Figure 1 tin-plate thicknesses vs standard tin-plate prices are shown, as of early 1960, for both black plate and ½ lb per base box electrolytic tin plate, 34-in. wide, TU grade. The price of hot strip that a finisher of tin plate would have to pay on the open market is also shown. In this case the plot is essentially a straight line going through the origin, since if one were producing half the thickness of final product, obviously only half the weight of hot strip would be contained therein, excluding scrap differentials. The shaded area indicates the conversion differential from hot band to final product, in this case coiled

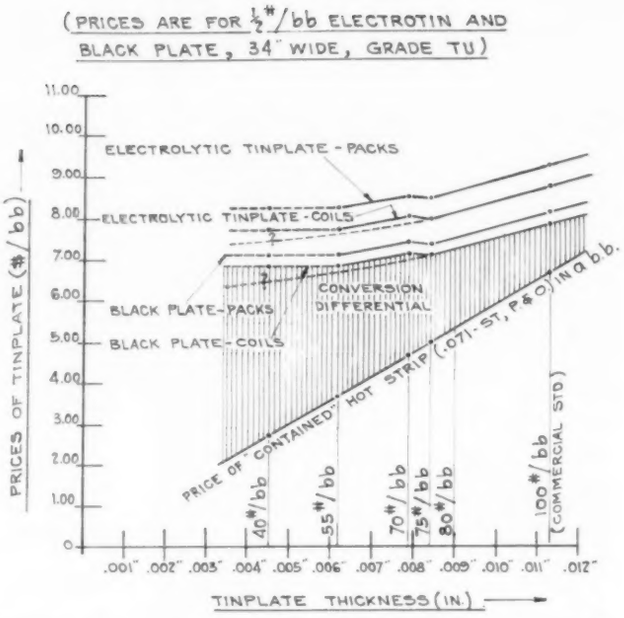


Figure 1 — Conversion of cost into dollars per base box yields a better index for comparison of standard tin-plate prices vs tin-plate gage.

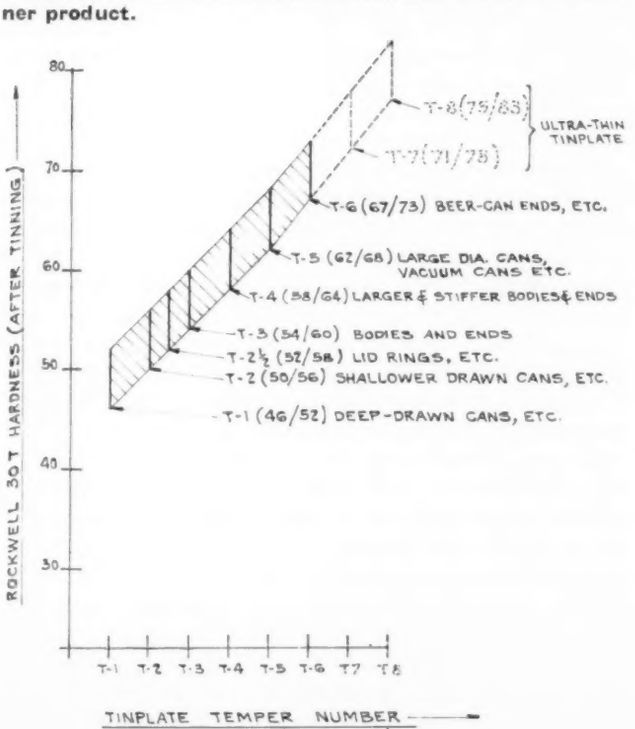
black plate. It is understood that actual costs are quite different than the figures shown, but the latter serve to pose the economic problem. Note that the current price picture shows no decrease in the price per base box below 55 lb per base box (0.0062 in.). Therefore, the basic question is how optimistically can the future price curve be extrapolated into the realm of the very light gages to achieve a lower price?

It is seen that the price curves for black plate parallel those for electrolytic tin plate, both for sheared packs as well as coils, by a constant differential of $1.15 per base box in the first case, and 90¢ per base box in the second. The conversion differential, shown shaded in the figure from pickled and oiled hot strip to coiled black plate covering cold reduction, electrolytic cleaning and annealing, temper rolling and including scrap, storage, handling and overhead is $1.20 per base box for 100 lb per base box, and $3.17 per base box for 55 lb per base box plate including increased scrap or decreased yield provisions. The reason that a comparison has been made between coils of tin plate, rather than sheared packs, is that coils represent a rapidly rising tendency to help reduce the ultimate cost to the tin can maker. Since more can-making machines are being equipped to handle full width coils, more than 50 per cent of all tin plate purchased by the large users is being requested in coil form. From the above figures, it is seen that the increase in the present conversion differential ($3.17 minus $1.20 equals $1.97 per base box) represents considerably more than a 100 per cent increase. However, the price reduction due to less contained steel is $6.60 minus $3.63 equals $2.97 per base box, so that a net over-all price reduction of $1.00 per base box is achieved. In considering the very thin product, 40 lb per base box (0.0045 in.), the price of contained steel is further reduced by 99¢ per base box; if the conversion differential could be kept from increasing by this amount, i.e., to less than $4.16 per base box, then an even lower price down to 0.0045 in., and thinner could be attained.

In addition to the question of tin-plate costs, an associated question is being asked, can the thinner tin plate be rolled to increased hardnesses or strengths to partially compensate for the thinner product and still maintain the price gains? In Figure 2 a graph of tin-plate temper specifications is shown, essentially as taken from *Hoare's Tinplate Handbook*,[8] in which is projected new and higher tin-plate temper numbers, T7 and T8, which are deemed desirable for the thinner product having Rockwell T30 hardness ranges of 71 to 78 and 75 to 83. Such increased hardness might be obtained either by altering the chemistry, varying the maximum temperature and/or cooling rates in the continuous annealing operation, or by an increased amount of reduction in the temper rolling or secondary rolling operation.

With two specific objectives before us, a less costly thin tin plate, and a harder tin plate, let us look at the likely problems to be met. The present price structure shows a constant differential of ½ lb per base box electrolytic tin plate in coils over coiled black plate, of 90¢ per base box over the entire range of tin-plate thicknesses. Based on the price of tin of $1.00 per lb, the cost of the ½ lb of tin would be 50¢ per base box, leaving 40¢ per base box as the price for the electrotinning operation. The price differential for shearing, sorting, etc., of electrolytic tin plate, also constant for all gages, is 50¢ per base box, and for black plate 25¢ per base box. If there is any appreciable increase in the difficulty of carrying out these operations, as the gage of the tin plate decreases, it is not reflected in any increase in pricing, and can be assumed not to be too significant at least down to 55 lb per base box plate. If the operations covered by the shaded area in Figure 1, covering cold rolling, cleaning and annealing and temper rolling (plus associated scrap losses and auxiliary operations) are looked at, there might be an inclination to compare

Figure 2 — Ultra-thin tin plate will have higher tin-plate temper specifications to partially compensate for the thinner product.



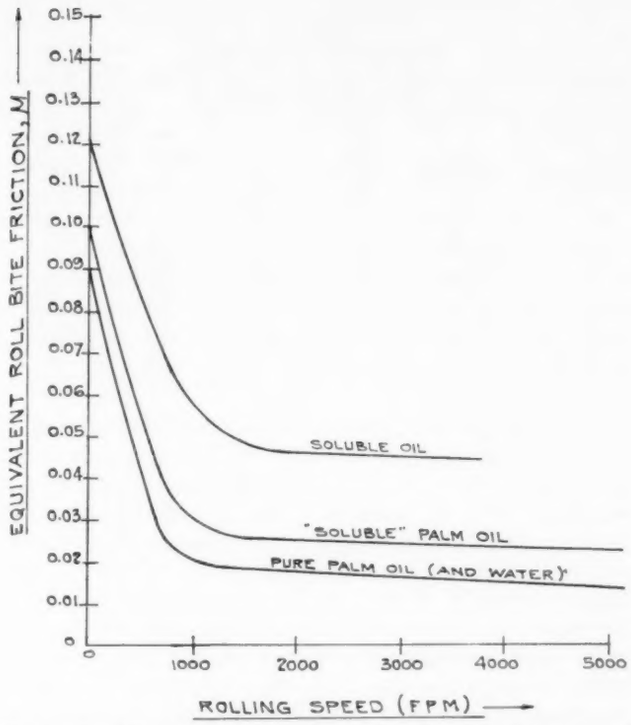


Figure 3 — The equivalent roll bite friction is a function of rolling speed and lubricant used.

the second of these operations, i.e., cleaning and annealing, with the previously discussed electrotinning and shearing operations as similar types of processing operations, which do not exhibit too much increased difficulty as the gage being handled is decreased. This comparison is not quite valid particularly for the lightest gages, for the real offenders and therefore the main causes of the increased conversion differential are primarily the rolling operations, the cold rolling and the temper rolling operations. Therefore, a closer look at the cold rolling problem is indicated.

The first question that appears is, can these thinner products be cold reduced on conventional tin-plate mills? If so, what modifications are necessary or desirable? More specifically, can 40 lb per base box tinplate stock be cold rolled at 5000 fpm on a conventional 5-stand tandem cold mill, having 21 to 23-in. diameter work rolls?

The subject of thin strip rolling has been given a considerable amount of study in recent years,[9, 10] and the minimum thickness that can be rolled on a given mill, under given rolling conditions, may be expressed by a simple linear equation as:

$$t_{minimum} = 3.58 \frac{D\mu\ (S_0 - S)}{E}$$

where:

- D = work roll diameter, in.
- t = strip thickness, in.
- μ = equivalent coefficient of friction in the roll bite, between strip and rolls
- S_0 = constrained yield stress, of the work-hardened strip, psi
- S = equivalent tension stress in the strip (75 per cent of entry tension stress plus 25 per cent of delivery tension stress), psi
- E = modulus of elasticity of the work rolls, psi

TABLE I
Rolling Schedule and Data
32⅛ In. Wide, T1-Grade, Rolled on a 20 and 49 x 48-In. Mill Using Soluble Oil and Additions

Stand No.	Strip thickness, in.	Per cent reduction	Speed, fpm	Motor input, hp	Strip tension, lb.
...	0.065	...	...	...	0
1	0.047	27.8	213	81	60,000
2	0.0252	46.5	400	1050	23,000
3	0.0125	50.5	800	1370	17,000
4	0.0074	40.8	1350	1460	3,000
5	0.0050	32.5	2000	1700	2,800
Reel	...	...	...	180	...

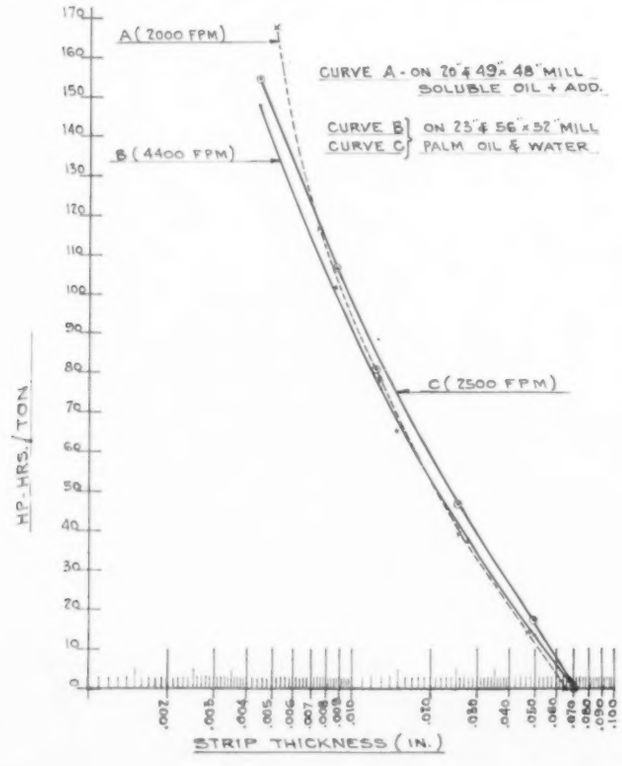
TABLE II
Rolling Schedule and Data
29 In. Wide, T4-Grade, Rolled on a 23 and 56 x 52-In. Mill Using Palm Oil and Water

Stand No.	Strip thickness, in.	Per cent reduction	Speed, fpm	Motor input, hp	Strip tension, lb
...	0.0700	...	...	...	0
1	0.0484	30.9	400	418	32,000
2	0.0277	42.8	700	1450	16,000
3	0.0149	46.2	1300	1880	4,000
4	0.0092	38.2	2100	2130	4,000
5	0.0044	52.2	4400	2860	1,000
Reel	...	...	...	130	...

Without going into the basis for the development of this relationship, it can be seen that the smaller the work roll diameter, the smaller the coefficient of friction and the higher the modulus of elasticity of the rolls, the thinner the strip that can be rolled. All of this has relevance to the type and strength of the product being rolled, which is characterized by the value (S_0). Of particular significance is the coefficient of friction (μ) which of course varies with the type of rolling oil being used, but is a significant function of the rolling speed, the higher the speed, the lower the value of μ.[9, 11] In Figure 3 is shown a plot of μ vs rolling speed for various types of rolling media that are used for rolling tin plate, which has been deduced from a number of full size power (and some pressure) tests on commercial tandem tin-plate mills at a number of speeds.

For hard tin plate that has been cold reduced from a 0.070-in. hot rolled band to 0.0045 in. (93.6 per cent over-all reduction) the constrained yield stress of the material will be about 115,000 psi. Utilizing a 24-in. diameter work roll, which is the modern tendency

Figure 4 — The energy required to roll ultra-thin tin plate vs reduction is illustrated by data gathered from actual mill tests.


A (2000 FPM)
B (4400 FPM)
C (7500 FPM)
CURVE A - ON 20 & 49 x 48 MILL SOLUBLE OIL + ADD.
CURVE B } ON 23 & 56 x 52 MILL
CURVE C } PALM OIL & WATER
HP-HRS./TON
STRIP THICKNESS (IN.)

(forged steel to take advantage of its higher modulus of elasticity), and considering rolling on a mill utilizing direct application of palm oil plus copious quantities of water for cooling, at a high finishing speed of 5000 fpm ($\mu = 0.015$), but using an effective strip tension in stand No. 5 of not more than 20,000 psi the limiting thickness (or thinness) of tin plate that could be rolled would be:

$$t_{minimum} = \frac{3.58 \times 24 \times 0.015\ (115{,}000 - 20{,}000)}{30 \times 10^6} =$$

0.0040 in.

For the softer grades of tin-plate stock utilizing higher strip tensions and a somewhat smaller work roll diameter (21 in.), a thickness of 0.0030 in. is attainable.

For temper rolling on a twin-stand tandem mill, one would probably use 12-in. diameter steel work rolls on the first stand, and 16-in. diameter steel work rolls on the burnishing stand. For tin-plate material at this metallurgical stage, the constrained yield stress of this material, only slightly rolled from the annealed state, is around 50,000 psi. However, with regard to bite friction in spite of high-speed temper rolling of around 5000 fpm, the value of μ that must be reckoned with is around 0.060, so that the thinnest tin plate that can be temper rolled is predicted to be:

$$t_{minimum} = \frac{3.58 \times 16 \times 0.060\ (50{,}000 - 15{,}000)}{30 \times 10^6} =$$

0.0040 in.

This value can be reduced using even smaller work rolls as well as higher effective strip tensions. Therefore, it can be seen that the possibilities technically exist of cold rolling and temper rolling tin plate down to 30 lb per base box substance, on more or less conventional mills, with appropriate modifications. The fact that this reduction is possible does not mean that it can be achieved without some penalties, such as higher rolling pressures accompanied by somewhat higher maintenance costs of rolls, bearings, etc.

Some test runs have been made on conventional 5-stand tandem mills, in order to further establish possibilities along these lines. Some runs were made on a relatively old mill (20 and 49 x 48 in.) rolling a relatively soft grade of tin plate (T1) from 0.065 x 32⅛ in. to 0.0050 in. at 2000 fpm. The mill's top speed was 2300 fpm, driven by motors operating off a common voltage bus, and utilizing a circulating soluble oil system with additions for increased lubricity. The rolling schedule and data were as shown in Table I and it should be

noted that all mill motors were operated at less than rated load with relatively high interstand tensions utilized where possible. The maximum over-all reduction of 92.3 per cent was dictated by the "speed cone" of the mill motors, limiting the over-all elongation to 0.065 in./0.005 in. or 13 to 1. The shape of the final product was fair, although not as good as for the conventional 80 lb per base box product, and some difficulty was had in handling the coils off the reels, as they tended to exhibit internal buckles and go egg shaped, since no special handling precautions were taken. The power to roll was as shown in Figure 4 on curve A, showing a total over-all figure of 168 hp-hr per ton.

Similar tests have been carried out on a modern 5-stand mill (23 and 56 x 52 in.) having a top finishing speed in excess of 6000 fpm, with separate generators driving each of the mill motors, and using palm oil directly applied plus copious quantities of cooling water. In the tests cited, a 0.070 x 29-in. harder tin-plate material (T4) was rolled down to 0.0044 in. at both low and high speeds (up to 4400 fpm) effecting an over-all elongation of 0.0700 in./0.0044 in. or 16 to 1 which was attained by operating at partial voltages on the earlier stands, see Table II. In this case somewhat lesser interstand tensions were used, and in spite of the larger diameter work rolls, the thinner final gages were rolled with less over-all power consumption, which one might conclude was due to the superior type of rolling lubricant used. At the highest rolling speed the motors on the earlier stands were only 40 per cent loaded, reaching up to 60 per cent on the last stand indicating that considerably wider ultra-thin tin plate may be rolled, at least powerwise. It is pertinent to note (Figure 4, curve B) that the energy consumed when rolling at 4400 fpm was only 148 hp-hr per ton, compared to that at 2500 fpm (curve C) of 155 hp-hr per ton, a difference of about 5 per cent. This difference again gives evidence of the lower bite friction existent at the higher speeds, as shown in Figure 3. It is to be noted that both figures are lower than for curve A, in spite of rolling a thinner product from a heavier starting gage. Thus the superiority of palm oil and water as a rolling solution shows itself to be of particular value when rolling to the very thin gages. The relative power saving is more than 15 per cent and the possibility of reaching the thinnest gages is greatly enhanced. It should also be noted that the reduction on the last stand, in spite of the larger diameter work rolls, was more than 50 per cent.

In both cases of rolling an analysis of the rolling pressures encountered, particularly on the last stand, show them to be considerably increased, of the order of 80,000 lb per in. of width, compared to about 50,000 lb per in. when rolling 80 lb per base box tin plate in the conventional manner. This higher specific rolling load results in a maximum Hertzian contact stress between the work rolls and the backup rolls of about 225,000 psi, which while not prohibitively high is some 25 per cent higher than for conventional tin-plate rolling. However, it must be recognized that the higher pressures will result in more frequent roll changes for redressing, to prevent premature spalling and preserve good surface conditions. For the specific rolling pressure cited the total rolling load for the 29-in. wide material is 2,300,000 lb, or 1,150,000 lb per. bearing, which is satisfactory for oil-film bearings even at the high rolling speeds used. It is to be expected that widths up to 38 in. might well be rolled down to these very thin gages. However, as even higher rolling speeds are reached, some curtailment of rolling pressure must then be considered. It is to be seen from Figure 4 that the rolling energy consumption for 40 lb per base box tin plate is around 160 hp-hr per ton as compared with an average of 105 hp-hr per ton for 80 lb per base box, which on a tonnage basis is 50 per cent more, but on a base box basis it is actually 25 per cent less. In both cases strip shape was found to be only fair, and the matter of coil stripping and handling off the reels pointed up some problems.

In looking toward the future, with regard to tin-plate rolling cost reduction, particularly with reference to the very thin gages, power costs per base box should be less. The same would seem to be true with regard to the cost of off-gage heavy coil ends because it is apparent that when the rolled gage is halved, the strip length is doubled, and the resulting percentage off-gage at the ends would also be halved, since the absolute lengths of the heavy ends should be approximately the same for both the lighter and the heavier gages, rolled at the same speed, with the acceleration and deceleration times of the mill being the same.

The general matter of reduced off-gage rolling that has been making significant strides of late, applies to the very light gages as well as to the conventional product. It seems pertinent at this point to indicate some of these gains. Referring to work by Holman,[12] who was among the first to apply automatic gage control to tandem tin-plate rolling, a comparison is made between manual and automatic gage control when rolling 85 lb per base box substance in 13,000-ft long coils, 34½-in. wide, at 3500 fpm at the Irvin works of the U. S. Steel Corp. Even though the ASTM thickness tolerance for cold rolled carbon sheets in tin-plate widths, for gages less than 0.0113 in. is ±0.0015 in., tin plate is conventionally supplied to a +0.0006 to −0.0011-in. gage tolerance specification. Charts showed that for the main body of the coils rolled, gage was generally maintained to within ±0.0003 in. when the mill was being manually controlled and to within ±0.0001 in. when it was under automatic control. This is not true for the coil ends which are always heavy (due to the increased bite friction at the lower rolling speeds, mainly below 1000 fpm) and may be as much as +0.0030 in. in some cases. However, automatic gage control has made it possible to significantly reduce the length of off-gage heavy ends. In a typical example, when the mill was being accelerated from 0 to 3500 fpm in 17 sec under manual control, it was rolling "commercial tolerance" tin plate after 14 sec, when the mill speed had reached 2315 fpm, but did not reach "aim gage" (0.0096 in.) until after 15½ sec more. Under automatic control commercial gage material was being rolled after 11 sec, at a mill speed of 1540 fpm, and was rolling aim gage material after only 2½ sec more, after 13½ sec, when the mill had reached 2270 fpm. The commercial off-gage heavy ends in the two cases figure out to be 190 and 110 ft respectively, and the aim off-gage heavy ends, 1100 and 200 ft respectively. The tail end off-gage strip lengths, during mill deceleration, are probably of the order of two thirds these amounts. Further checks

TABLE III
Lubricant Effectiveness

Tandem cold mills, 5-stand	Operating speed range T1 to T6, fpm	Coolant lubrication system	Average product, in.	Average Production, 1957	
				Excluding maintenance backup roll changes, etc., tons per turn	Including all delays, tons per turn
Mill No. 1	4500 to 4000	Direct palm oil and water up to 8000 gpm	0.0094 × 33	720	600
Mill No. 2	4200 to 4200	Direct palm oil and water 3500 gpm	0.0095 × 33	690	577
Mill No. 3	3900 to 3600	Recirculating soluble oil and additive 2000 gpm	0.0094 × 33¼	645	540

by means of the wrap check method of average gage determination, on 500 coils, indicated that 80 per cent of automatically controlled coils have an average thickness within plus and minus one per cent of the mean, as compared to 60 per cent for manually rolled coils the outer limits being ±2¼ per cent for automatic vs ±6¼ per cent for manual. As has been inferred previously, the longer the coil being rolled, the smaller the percentage off-gage due to heavy ends. In the case discussed above, the coil weight was 15,000 lb corresponding to 430 lb per in. of width, and it is interesting to note that one of the new plants currently being built will handle 90,000-lb coils, 45-in.-wide, corresponding to 2000 lb per in. of width, making a coil length of 66,000 ft for 80 lb per base box plate, which would correspond to 132,000 ft (25 miles) for 40 lb per base box tin plate.

In addition to cost reductions due to better gage control, and it is certain that additional progress has been made since Holman's report, such as the application of the BISRA gagemeter system to tandem mills, the adoption of automatic gage control for hot strip mills supplying hot bands to the cold mills, etc. A major line of promise would be to roll tin plate at much higher speeds. However, the accomplishment of this objective is not as simple as it seems, since it might be said that the rolling of tin plate has reached some sort of a speed barrier, at least for the time being. Since the early days of tandem mills for rolling tin plate, the top design speeds of the mills have increased from 1600 fpm in 1930 to 7000 fpm by 1955, with an accompanying increase in operating speeds of from 1500 to 4500 fpm over this same period. Even though mills continue to be built with top design speeds of 6000 to 7000 fpm in the hope and anticipation that rolling speeds can be pushed upward, the last five years have shown only slight advances. The top operating speed figure varies with the various temper numbers being rolled, and also varies from mill to mill depending on several operating factors, but primarily on the type of roll coolant-lubricant system employed. In all cases the top speed is determined mainly by the appearance of "friction scratches" or "friction pickup" on the surface of the cold reduced tin plate. Although the exact mechanism of the phenomenon is not thoroughly understood, it seems to be pretty clearly associated with the breakdown of the lubricant in the roll bite. As one would expect this breakdown varies with the type of lubricant used, the effectiveness of cooling, etc. From a comparison of three typical 5-stand tandem tin-plate mills, as shown in Table III, it can be seen how top operating speeds and production can be associated with the effectiveness of the roll coolant-lubricant systems employed. Mill No. 1 regularly rolls T1 material at 4500 fpm, and frequently rolls as high as 6000 fpm, but when harder material (T6) is being rolled the operating speed is dropped to 4000 fpm. This mill uses the direct application of palm oil plus copious quantities of cooling water, and has the highest average production record. In the mill the diameter of the work rolls has been increased to 23 in., and it has been felt that less friction scratching takes place than when 21-in. diameter rolls were previously used. It is believed to be due to their greater thermal capacity.

Mill No. 2 uses the same type of coolant system, but with a lesser potential quantity of water and somewhat lower production figures are shown. Mill No. 3 uses a recirculating type of soluble oil and water system, with an additive oil or synthetic palm oil, with a still lower volume of coolant applied to the mill. While the coolant costs are somewhat lower for this type of system, the mill runs hotter, as evidenced by the general "steamier" conditions around the mill, and the top speeds are some 500 fpm lower, on the average than for mill No. 1 with correspondingly lower production figures. Since it is recognized that lower lubricant temperatures generally mean increased lubricity, a study was made on mill No. 2 of the effects of coolant water temperature variations from summer to winter on the output of the mill, with the results as revealed in Figure 5. Although the average production over the entire year (1957) was 577 tons per turn the average winter figure was 593 tons per turn and the summer average was 556 tons per turn with the average water temperatures 50 and 77 F respectively. A similar but somewhat improved picture was obtained in 1958, thus adding confirmation to the theory that the problems of friction

Figure 5 — The influence of roll coolant temperature on mill production was studied for a period of two years.

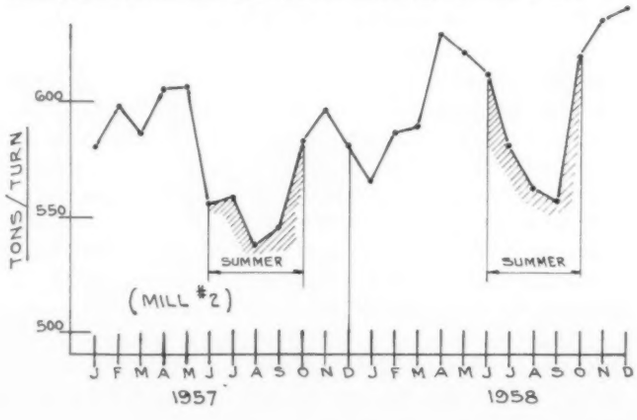


TABLE IV
Motor Tabulation*

Stand No.	Motor No. and horsepower	Type motor	Total horsepower per stand
1	2 × 1500	Single armature	3,000
2	2 × 2500	Single armature	5,000
3	2 × 2500	Single armature	5,000
4	2 × 3000	Double armature	6,000
5	2 × 3000	Double armature	6,000
6	2 × 3750	Triple armature	7,500
Reel	2 × 1200	Double armature	2,400
		Total	34,900

* For a 6-stand tandem cold mill (23 or 24 and 56 × 52 in.) with a maximum delivery speed of 7000 fpm.

scratches seem primarily a matter of roll bite temperature.

Reflecting the observations recounted above of undesirably higher rolling pressures when rolling ultra-thin tin plate on a 5-stand mill, and recognizing that roll bite temperature particularly on the last stands limits the rolling speeds, the conviction is gradually emerging that a 6-stand tandem cold mill would help solve both of these problems. Dividing the total overall reduction over six stands, as compared to five, will reduce the rolling pressures considerably, and hence roll and bearing maintenance probably by the order of 25 per cent. Equally as important, the bite temperatures should be reduced, since there would be six mills to help conduct heat away and five interstand spaces, rather than four, where the strip can be spray-cooled directly. With more attention to the volume and distribution of water or rolling solution used, as well as its temperature, significant increases in maximum operating speeds are to be anticipated.

A start along these lines has already been made; about 18 months ago the first 6-stand tandem cold mill was ordered. It is scheduled to go into operation in 1961. A second 6-stand mill has since been ordered, and others are being considered. The first mill being built for a maximum operating speed of 7000 fpm, will use 24-in. diameter rolls on the last stands and will be provided with up to 11,500 gpm of rolling coolant/lubricant, either recirculating soluble oil plus synthetic palm oil or palm oil direct plus water. The mill will be the heaviest powered tandem tin-plate cold mill yet built, all stands having twin drives with a total of just under 35,000 hp, see Table IV. All stands will be provided with load cells (to control rolling pressures) and interstand tensiometers. Automatic gage control will be incorporated, utilizing two X-ray thickness gages, controlling the screws of No. 1 stand and interstand tensions between the last three stands. Not only does such a mill provide the promise of the commercial rolling of ultra-thin tin plate, but it should also help to push the speed barrier upward even for conventional tin-plate gages. Another potential economic advantage would be the utilization of heavier gage hot bands, which should certainly reflect a lower cost of starting product.

There are some who express the thought that decreasing the average gage off the 5-stand tandem cold mill from say, 80 to 40 lb per base box will cut the tonnage of the mill in half, perhaps from 600,000 to 300,000 tons per year, and that this would result in a much higher burden of fixed charges. Looked at purely from a tonnage point of view this concern is correct, but since tin plate is bought and utilized as an area product, the production measured in base boxes would be the same for either product, if the operating speeds are the same; and hence the fixed charges per base box would not change. Furthermore, the dollar value of the annual production off such a mill, producing the lighter product, would only decrease by a small amount, specifically by the amount that 40 lb per base box tin plate could be sold cheaper than 80 lb per base box substance.

Nevertheless, looked at from this point of view, and recognizing that for the present, ultra-thin tin plate represents only a small per cent of the tin-plate market, some producers are considering the use of a separate additional cold mill, for performing only the final rolling reduction from say, 80 to 40 lb per base box product or from 0.0090 to 0.0045 in. in the full hard condition. The thought is developed further that the mill should be a reversing mill with very small work rolls, of the order of 2 to 3 in. It is felt that the use of a very small work roll in the mill is not only unnecessary for the rolling of thin tin plate, but it would represent a costly operation due to its necessarily lower speed of rolling and the uncertain strip shape that would result. It is only necessary to remind ourselves of the earlier observations that more than 50 per cent reduction on fully work-hardened tin plate was taken when going from 0.0092 to 0.0044 in. (Figure 4 and Tables I and II) on a mill with 23-in. diameter work rolls, utilizing direct application of palm oil and rolling at from 2500 to 4400 fpm. The use of relatively large work rolls in the rolling of tin plate has increased over the past two decades, increasing from about 18-in. diameter (the original size of the work rolls on mill A, Figure 4 and Tables I and II) to 23/24-in. diameter for the modern mills for two main reasons: longer work roll life, requiring less frequent roll changes; and less friction scratching tendencies and better strip shape, as a result of less heat distortion. Therefore, if this separate additional rolling operation were based on a single 1-way 4-high mill (or a 2-stand tandem mill) utilizing palm oil and water with somewhat smaller work rolls than are used for conventional tandem tin-plate mills, and rolling at speeds of 3000 fpm and upward, much of the extra cost of this additional rolling operation could be considerably reduced. Because the above method of achieving very thin tin plate involves a separate and additional rolling operation, including extra handling, personnel, etc., it is felt that it can be only considered a transitory expedient, and that when this product attains considerable production requirements, tandem rolling as discussed earlier will be preferred, as has been proved in the past.[1] It may be pertinent to observe that one of the few 4-high reversing cold mills rolling tin plate (in addition to other products) in America, is a 9¼ or 18 and 53 x 56-in. mill backup roll driven, having a top speed of just over 3000 fpm. This mill will certainly be able to roll down to the ultra-thin tin-plate range by taking one or two extra passes over present schedules.

In thinking about how to solve a new problem, it is to be expected that alternate possibilities will occur to many people. One such possibility as experimented with by one producer is to cold reduce, by passing the strip

twice through the 5-stand tandem mill with or without an appropriate intermediate anneal, this of course would add the cost of two additional operations. In one case where the ultimate in thinness was being investigated, strip 0.0800 × 30 in. was rolled down to 0.024 in. on the first tandem pass, then annealed, and further reduced from 0.0240 to 0.0040 in. on the second tandem mill pass. Further processing was expected to be along usual lines.

Still another thought has been to consider rolling two thicknesses of strip through the 5-stand mill, similar to the rolling conventionally done in the very thin aluminum foil field. By starting with two thicknesses of hot band at 0.048 in. (2 × 0.048 in. = 0.096 in.) the mill would roll down to a double thickness of 0.0090 in., which would produce two strips each having a final gage of 0.0045 in. Pressure and powerwise the rolling on the 5-stand mill would not be abnormal. Further research and experimenting would have to be done to determine if it were practical to operate off two uncoilers and "double" the two strips as they entered the first stand, followed by a similar "undoubling" operation out of the fifth stand, in conjunction with dual reels, or whether it would be necessary to retain separate doubling and/or undoubling operations, as is customary in aluminum foil rolling.

There would be some concern about the appearance of the strip rolled in this fashion, since the inside surfaces would be dull compared to the bright outside surfaces. However, this would be a distinct advantage for differential electrolytic tin plate, in that the difference in luster would serve as an automatic marking means of distinguishing the two sides, and replace the usual special processing step in the electrotinning line. Even though only about 10 per cent of electro-tin plate is used as differential tin plate at the present time, can makers have stated that if this method of rolling gave promise of an economically produced thin tin-plate product objections to the different lusters might be circumvented even for general applications. However, one adverse factor would be the thinness of the starting hot strip product, in the neighborhood of 18 gage, which is almost at the lower limit of strip thickness that can be produced off the hot strip mill, even if the higher cost of hot rolling could be justified. On the other hand, if successful, this method would tend to maintain high tonnages off the tandem mill, corresponding to almost twice the base box production of other procedures.

The conventional procedure of producing ultra-thin tin plate would involve temper rolling as well as cold rolling. Whereas, in the earlier days before the more general adoption of continuous annealing, the rolling reductions used in temper rolling of tin plate sometimes reached 6 per cent and more, recently the tendency has been toward smaller reductions, of the order of 2 per cent, and less. The main reason for the change has been that when tin plate is batch annealed in coils, the product is softer and requires more cold rolling to obtain the higher tempers. In the continuous annealing process the annealed product is not as soft, and indeed its hardness can be controlled within limits by the maximum temperatures and cooling rates employed so that less dependence on cold rolling to get final hardnesses is required. The product has a uniquely better combination of stiffness and ductility, and is a product with less directional properties making a more universally usable product, hence the growing use of the term universal temper or TU to designate continuously annealed tin plate. The function of the temper rolling operation is reverting to more of a skin passing operation, where suppression of the yield point elongation and stretcher straining, along with a smoother surface and a flatter product are the primary objectives. All of this has particular relevance for the ultra-thin tin-plate product, which as was indicated earlier, would be harder to temper roll than conventional tin plate. Even though it is felt that it remains within the realm of possibility to temper roll 30 lb per base box substance by going to smaller work rolls and higher strip tensions, the rolling pressures might become excessive if too high percentage reductions were required.

Associated with both types of rolling operations, as well as the continuous annealing and continuous electrotinning operations, is the matter of handling this very thin product, both as a strip and as a coil. In the experimental runs that have been made, generally poor yields have been obtained, and there are those who view the handling and processing of this thin material as even more serious than the rolling. Perhaps the use of sleeves on all reels will have to be resorted to as is done in the manufacture of thin aluminum foil. Perhaps, also side trimming of the strip will have to be reverted to again as an initial step in the continuous annealing line to prevent tearing. In any case the continuous annealing operation looms as the most difficult processing step, due to the necessity of dealing with the strip in its softest and weakest condition. A thought along these lines, to reduce both the difficulty of and the amount of handling would be to combine the continuous annealing and temper or skin rolling operation into a single combination line thus eliminating the coiling operation of the annealed product. This would constrain the tempering operation to be carried out at somewhat less than half its conventional speed, but the reduction in personnel, elimination of interoperation handling, and reduction in tearing hazards might well be overriding considerations.

The potential handling hazard of this very thin product has so impressed some tin-plate producers, that a different approach is being studied. The idea is to process and produce coils of electrolytic tin plate in the conventional manner and at conventional gages, and then to cold reduce this product by from 20 to 50 per cent to meet final specifications on a separate cold mill. For instance if 40 lb per base box, ½ lb per base box electrolytic tin plate were to be produced, then 60 lb per base box material having a ¾ lb per base box electrolytic coating would be produced as at present, and a final 33 per cent cold reduction would yield the final product. Enough work has been done recently and in the past to show that the tin coating and the base metal will reduce together proportionately and that there is no objectionable pickup, so that the surface of the final product should be acceptable. In fact if polished rolls are used a bright product will result, as was proposed some time ago as an alternate method of transforming the matte surface of an electrotinned strip into a highly lustrous product, acceptable to the can maker and the housewife. Moreover, the adoption of this method might eliminate the necessity for flow

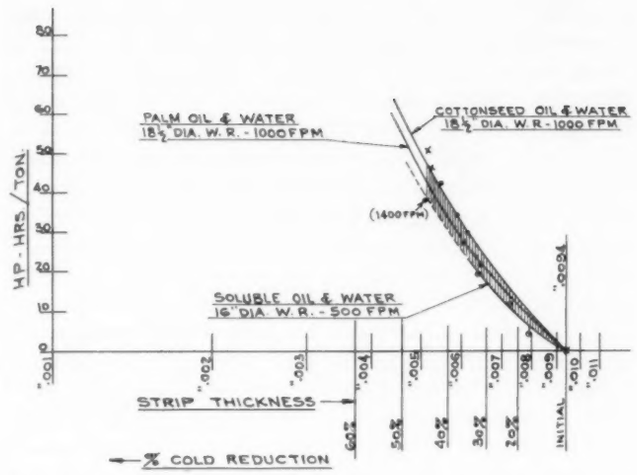


Figure 6 — Energy vs reduction curves have been drawn from data obtained from tests on both single-stand and 2-stand mills.

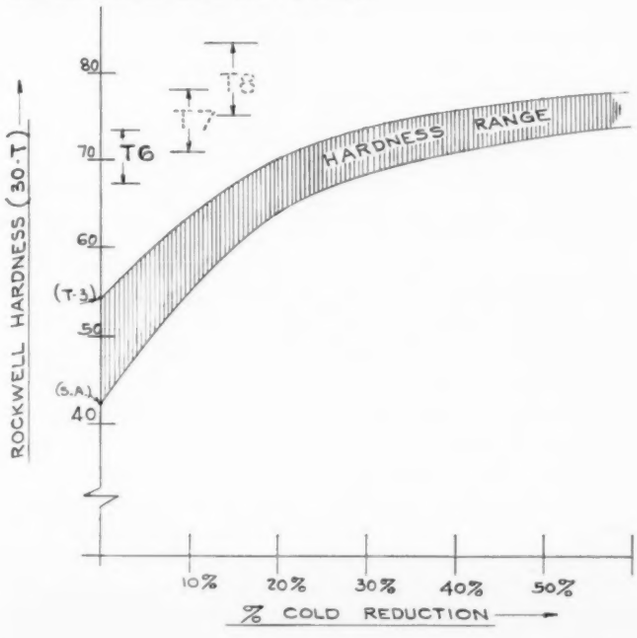
brightening in the electrolytic line, when the slight alloy layer formed in the latter process may not be of worthwhile value. Since tin is a very soft metal, its value as a rolling lubricant might conceivably be sufficient, together with the surface protection oil off the tinning line, to obviate the necessity for the use of additional rolling oil, which would have to be subsequently removed, at least for the lesser reductions mentioned.

There, of course, would have to be some development work carried out as to the best type of mill to perform this final rolling operation. A disadvantage of a product made in this manner would be the relatively high order of directionality of properties, compared with the current TU type of tin plate, but possibly not too much different than the earlier type products. Of course, its hardness would necessarily be in the upper ranges (T5 and above), reaching up to the T8 temper discussed at the beginning of this article. This should not be a disadvantage, since it is anticipated that whenever ultra-thin tin plate will be used, the maximum in hardness or strength will also be desired, to compensate for its thinness. If this type of product should prove technically interesting to the tin can makers, its potential cost picture seems particularly promising. Starting with the current quoted price for 60 lb per base box, ¾ lb per base box electrolytic tin plate of $8.20 per base box, the tonnage price at 33⅓ base boxes per ton becomes $273 per ton. The end product, 40 lb per base box, ½ lb per base box electrolytic tin plate, shows a quoted price of $7.70 per base box (Figure 1), which at 50 base boxes per ton represents a gross figure of $385 per ton, an increase of 41 per cent, equal to $112 per ton. There should be every expectation that the over-all cost of the final rolling operation discussed above, including electrolytic cleaning and passivating where it proves necessary, extra handling and scrap provisions would be some attractive percentage of this price differential, and thus result in a cheaper ultra-thin tin-plate product.

Following along this line of thought considerable experimental work and pilot plant operations have recently been carried out by several tin-plate producers to evaluate the technical and economic aspects of this approach. Experimental rolling has been carried out on various mills having work roll diameters varying from 12 to 21-in. diameter (also on mills having 2½-in. diameter work rolls) with various types of lubricant combinations including palm oil, soluble oil and cottonseed oil (and tests have also been run dry) over a range of relatively low speeds, up to 1400 fpm. In Figure 6 are shown some of the more pertinent results, referred to a starting gage of 0.0094 in. (85 lb per base box). Starting materials have included various tempers from soft annealed to T3, various coatings weights up to ¾ lb per base box (including black plate) and various chemistries so that the data necessarily are better shown as a range. Various reductions up to 50 per cent per pass and more have been taken on both single-stand and 2-stand tandem mills, and other mills. Where palm oil can be used (it may be objectionable from the point of view of chemical attack on the tin coating), it shows less power consumption than other types of lubricants. However, in spite of using soluble oil and water, even less power and rolling pressure are required if the work roll diameters are decreased to 16 in. and less. In the range of tests so far carried out, a significant speed effect is indicated, as is to be expected in the rolling of very thin strip, where bite friction plays so important a role. Thus for a 50 per cent reduction, a rolling energy range of from 60 hp-hr down to 48 hp-hr per ton has been obtained, and even less is to be expected at speeds of 3000 fpm and higher.

It is interesting to compare these figures with those that can be extracted from Figure 4, for rolling full hardened strip from 0.0094 to 0.0047 in. where a figure of 48 hp-hr per ton is shown at speeds of 2500 to 4400 fpm, when using palm oil and water and 23-in. diameter work rolls. This energy value exceeds 80 hp-hr per ton for soluble oil at 2000 fpm in spite of the use of 20-in. diameter work rolls. Test rollings on dry electrotinned strip (with surface protection oil off the tinning line left on) showed that a 20 per cent reduction was possible, which indicates that the tin does act as a partial lubricant, but the lack of adequate cooling resulted in poor shape. Rolling pressures varied from 25,000 lb per in. for a 20 per cent reduction to about 50,000 lb per in.

Figure 7 — Secondary rolling of ultra-thin tin plate could produce hardness in the T8 range.



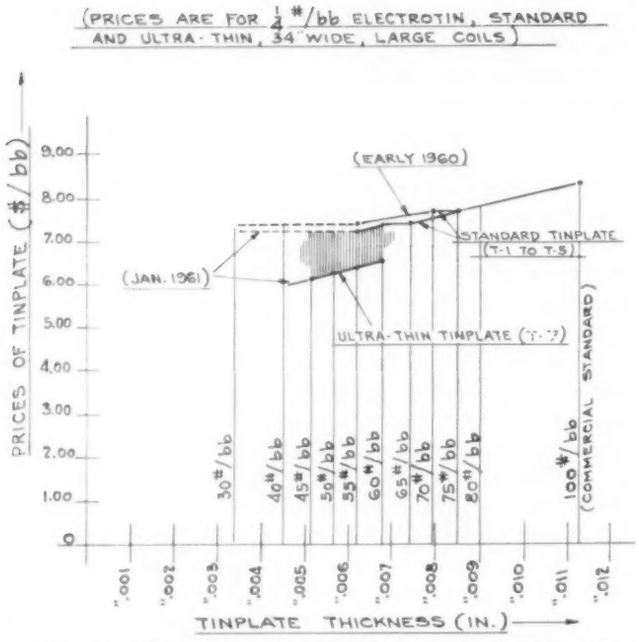


Figure 8 — Comparison of ultra-thin and standard tin-plate cost vs gage, for 12,000-lb or larger coils, shows a marked price reduction for the ultra-thin product.

for a 50 per cent reduction per pass, so that no excessive rolling pressures are involved in this secondary rolling operation.

Various types and grades of steel have been experimented with in these recent trials. Figure 7 shows the range of tin-plate hardnesses (Rockwell 30-T) that seem to be indicated. A 30 per cent reduction would produce hardnesses in the T6 range, while a 50 per cent reduction would reach into the currently discussed T8 range. While it has been variously and erroneously stated that after a certain reduction, not much additional increase in hardness is obtained, the hardness curve does flatten out considerably and the hardness range narrows as well. It should be emphasized that the hardnesses obtained in this method of production result primarily from cold rolling, as compared to the hardnesses in the standard tin-plate category where they are obtained by a combination of chemistry, annealing cycle and a minor amount of rolling (temper rolling). Thus this new ultra-thin tin-plate product will not only be harder, but more directional in its properties, and not satisfactory for all uses of tin plate.

The production steps in this process will be contrasted here with the more conventional procedure. If it is desired to produce ultra-thin tin plate along customary lines the following processes are involved: reducing from 0.080 to 0.0045 in. on a 5 or 6-stand tandem cold mill; continuous electrocleaning and annealing; temper rolling, cleaning and pickling; and continuous electrotinning followed by reflowing, passivating and oiling in the same line. Four separate operations all handle strip in the ultra-thin gages. The modified procedure that has been discussed would include: reducing from 0.100 to 0.0090 in. on a 5 or 6-stand cold mill; continuous electrocleaning and annealing; and electrotinning (probably by-passing the temper rolling operation) with its attendant auxiliary processing all at customary thicknesses. The product would then be further reduced in a second cold reducing operation, either on a single-stand or a 2-stand tandem cold mill, to 0.0045 in.; after which it would go to a final (new) processing line, to remove rolling oil and passivate the newly rolled tin surface (and perhaps even reflow again). This joint procedure involves five operations (six if intermediate temper rolling were retained) three at conventional gages, and two in the ultra-thin state. This leads one to consider yet another procedure, aimed at improving the quality of the product even further, particularly as to surface, and at even lower costs. Consider now, performing the second cold reduction operation (similar to that discussed earlier) directly after the first two steps of primary cold rolling and continuous annealing. The final operation would be to process through existing electrotinning lines, most of which are supplied with adequate electrocleaning facilities to remove all rolling oils. This procedure would involve only four separate operations, two at conventional thickness, and two at ultra-thin gages. Thus the need for new processing lines, for cleaning, passivating, etc., such as mentioned earlier, would be eliminated, although tinning line capacity would be reduced by virtue of handling thinner gage. The hardness of the final product would be the metallurgical equivalent of the previously discussed processed product, and the surface condition would be the full equivalent of the conventional product.

For many tin-plate applications, where the properties of this new ultra-thin product are acceptable, the early promise of a cheaper product discussed last year[13] is already on the road to being realized. In Figure 8 a chart is shown similar to that shown in Figure 1, but limited to large coils (above 12,000 lb) and having a coating weight of ¼ lb per base box, which runs 25¢ per base box less than for the ½ lb per base box coating shown in the earlier figure. Standard tin plate, in the gages below 75 lb per base box, has undergone a price reduction of about 20¢ per base box reflecting improved techniques in spite of increased labor costs, etc. Also, the ultra-thin product, of the harder variety (by rolling) shows a further marked price reduction, of more than a $1.00 per base box in the lighter gages, as compared with the standard product. Thus the results of modified techniques are already obvious, in making available to the can makers, a thinner, lighter and lower cost tin plate to meet the challenge of aluminum, etc.

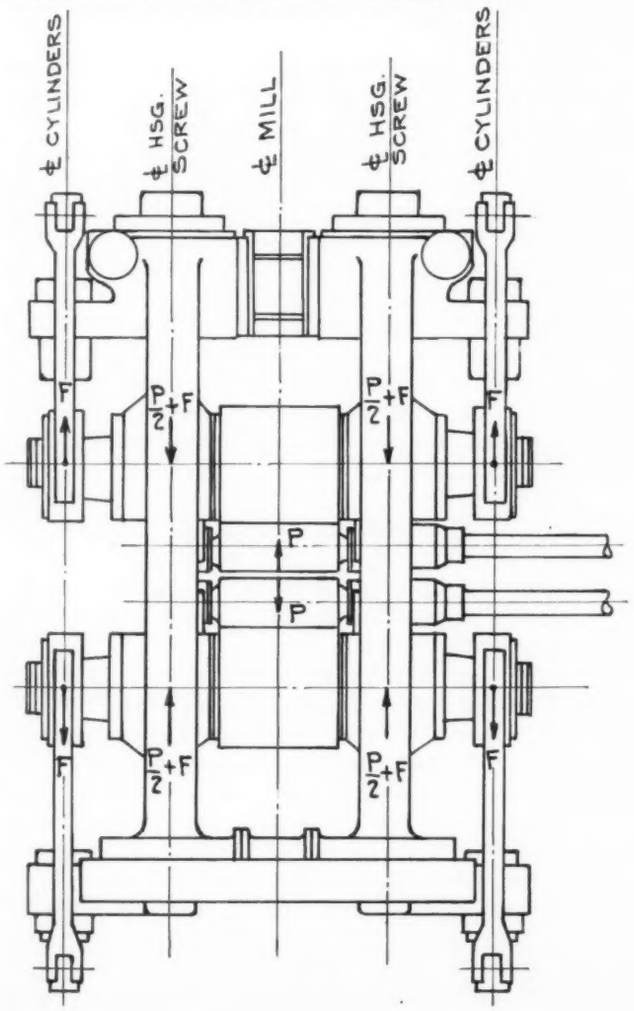
As has been mentioned several times in this article, one problem that seems inevitable, whatever process is used, is that of maintaining a satisfactorily flat product, comparable or superior to current standards. As is well known and as is exemplified again by aluminum foil, the thinner the strip being produced, the more sensitive is the shape of the strip to operating variables. Shape is defined as the ability of the strip to lie flat on a table, and not the constancy of thickness or gage from edge-to-center or end-to-end, which is determined by the condition of the hot strip coming to the tin plate department. The flatness of rolled strip is a function of the correct relationship of rolling pressure, strip tension, and roll crown, and if any of these varies, from a multiplicity of causes, such as thermal build-up in the rolls, roll wear, changes in strip widths, thickness, or hardness, etc., then either an under-rolled or an over-rolled strip results. The remedy for such conditions is to change rolls to provide the correct crown, as a given crown is correct only for one set of operating conditions.

Therefore, for any other operating condition, the existent crown represents a compromise between the correct amount and the amount found least objectionable over the range of conditions encountered. Sometimes crown may be altered by the use of gas flames or radiant heaters, as is often done in temper rolling, or by control of coolant distribution, as has been highly developed for aluminum foil rolling, but at best, these methods are slow in response and limited in range and accuracy.

A new departure in rolling mill design and technique of operation has recently been developed that bids fair to mitigate the problem of controlling crown. This development, while new to the rolling mill field, has been used successfully since 1953 in rubber and plastics calendering,[14] and is based on the idea of roll bending, by hydromechanical means. A similar development has recently taken place in the even more difficult field of paper calendering.[15] Concurrently, a large 4-high mill (26 and 57½ x 144 in.) for the cold and temper rolling of aluminum alloy plate and sheet to very close tolerances of gage and flatness, is being equipped with similar means, and should soon be in commercial operation.

Crown, or contour control as the name implies, is the simple process of inducing a bending deflection in a roll by applying equal and opposite bending moments at each end of the roll. Such bending moments, acting opposite to those produced by the rolling pressures, will have the same effect as an increase in the mechanical crown. In Figure 9 is shown a 4-high mill, which could be the last stand of a tandem tin-plate cold mill, or of a twin stand temper mill with provision for crown control of the backup rolls. Some efforts along the lines of varying the crown of rolling mills by deflection of the work rolls has been practiced for some time now, but the effect obtained in this manner can only be small, due mainly to varying roll contact flattening, as the shape of the work rolls is determined basically by the shape of the backup or support rolls and the mechanically ground crowns. An article of interest on this general subject was recently published by Singer.[16] It is anticipated that this new development in the rolling mill art will do for lateral control of gage and flatness what automatic gage control has been and is doing for longitudinal gage correction.

Figure 9 — Crown adjustment of the backup roll, accomplished by hydromechanical means, permits changing of the lateral contour of the strip during rolling.



In this article some of the various possibilities for the commercial production of ultra-thin tin plate have been reviewed. Its commercial production will represent yet another major development in tin-plate making since the 1920's. The article has attempted to explore some of the facets of the several methods being considered by various producers, with the objective of holding out the continued promise of a cheaper product in the 30 to 55 lb per base box range, so that tin plate may be able to continue its growth in the ever more competitive container field. It is hoped that one or more of the several ideas reviewed will contribute to the economic production of a thinner tin-plate product, and will become a commercial reality sooner than prophesied.

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Automation and Process C

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. . . . in the summer of 1960 W. E. Miller spent 11 days in Russia, part of which was in attendance at the First Congress of the International Federation of Automatic Control, while R. M. Sills visited in Czechoslovakia for a like period, during which time he was able to visit two steel plants. In addition, numerous discussions, both with Russian engineers and with engineers from within the Soviet sphere of influence, and tours of laboratories and other plants have given them a comprehensive view of the Soviet iron and steel industry and its goals for automation and process control systems. Some of the material in this paper has been extracted from the proceedings of the First Congress, International Federation of Automatic Control, Moscow, USSR, and since published by Butterworth's Scientific Publications, London, England. . . .

THE United States has already learned with considerable shock of the rapid progress made by the Soviet Union in the field of missiles. This progress has been achieved by extreme concentration of effort in a field considered important. The Soviets attach almost a comparable degree of importance to their iron and steel industry.

Soviet steel industry management confidently expect to surprise, and even shock the U. S. by similar progress through automation of their metallurgical industry.

"This is because the metallurgical industry is justly considered foremost among the key industries of economic and social progress. The economic power of nations may also be measured upon an index of kilograms per inhabitant of the metallurgical products annually produced or consumed."

There is doubt that we in America any longer think in these terms, but this is the degree of importance attached to the development of the iron and steel industry by the Soviets. The new and underdeveloped nations attach the same importance to the establishment of their national steel industries.

THE POSITION OF THE WEST

Contrary to the impression given by some comparisons the communist world does not appear to be outexpanding the Western world.

Total Western world steel production increased from 233,000,000 net tons in 1959 to 263,000,000 in 1960, an increase of nearly 13 per cent. During the same period the total communist world production increased from 101,700,000 to 112,500,000 net tons, an increase of under 11 per cent and of course considerably less in magnitude. The Western world gain was achieved in the face of a drastic second-half slump in U. S. output, which limited its gain to about 6,000,000 tons or 6.3 per cent.

There are, of course, exceptions to the trend. These are chiefly in countries where production is small.

Control in the Soviet Iron and Steel Industry

Czechoslovakia more than doubled production between 1937 and 1958, and by 1965 will approximately double it again if their plans are carried out. China approximately tripled production between 1943 (the best year for the "old China") and 1952, and since then its production has been increasing at an average rate of nearly 33 per cent per year. From 1959 to 1960 this rate was 36 per cent, to a production last year of 20,000,000 tons. In the next five years they plan to increase the capacity by 90 per cent.

Based on present plans for expansion in the next five years the communist steel capacity will grow at approximately twice the rate for the Western world (47 per cent vs 23 per cent), but the Western world will add more tons of capacity.

The situation in the electrical power industry is quite similar. While the rate of increase in power capacity in the USSR is greater, the U. S. lead is actually increasing. In this connection it should be noted that while only 48 per cent of U. S. power is used for industry the USSR devotes 80 per cent.

While the U. S. should not be ashamed of its present rate of progress, it should be recognized that there is a formidable and determined competitor on the other side of the iron curtain. Considering the size of their steel industry and the state of development of their industry in general, the expansion that they have made since World War II and are planning for the next few years represents a tremendous achievement. How do they plan to do it?

RUSSIAN AUTOMATION AND ECONOMIC DEVELOPMENT

All indications are that the USSR has placed its economic future in the hands of the automation and the systems engineers. This extreme concentration on the development and application of advanced automation theory and techniques is expected to raise product quality and productivity of the individual worker to levels surpassing that of the Western world, according to Soviet engineers. This goal is not expected to be achieved overnight, nor within a year. A high official in one of the institutes of automation indicated that in the steel industry this time is five to ten years away.

Soviet leaders and engineering management recognize that this all-out effort will delay improvement in the standard of living, and affect short term cost position. But they are convinced that the long term program is sound and worth short term sacrifices. "In the West," they said, "you must pay most attention to the one to three year profit."

These automation institutes are charged only to work for the best long term engineering solution, not to produce tangible designs for the present. "Cost," they said, "is relative to your objectives. The cost of our operation is not chargeable to the cost of electrical equipment or to the cost of steel, but to the cost of economic development, a cost of government."

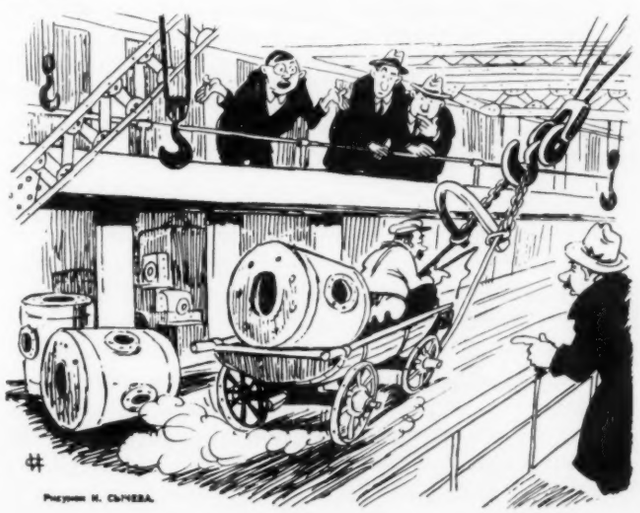
The resulting operation is a tremendous number of engineers looking at over-all systems problems and attempting to apply theory and engineering concepts to determine optimum over-all systems solutions. This all-out engineering effort is the first step in a long range plan to achieve economic superiority through widespread and large scale automation.

The importance of automation to the development of Soviet economy is constantly being explained to the populace. Posters and sign boards in parks, exhibit halls and many other places graphically picture a continually growing Soviet economy and an eventually dying capitalist economy. Application and wholehearted acceptance of automation by Soviet workers are pictured as the key to eventual Soviet superiority in the economic race.

SOVIET DEFINITION OF AUTOMATION

It quickly became evident that the terms automation and computer have significantly broader meanings to the Soviets than to U. S. engineers. The Soviets might say a facility is automated if work is transported automatically by conveyor (Figure 1) from one hand work station to another. A computer control system might

Figure 1 — "How is the transport? Completely mechanized!" This cartoon appeared in the Russian magazine *Krokodil*.



consist of a simple analog comparator or integrating circuit for some special function, or a process could be completely automatic with ingenious special purpose computing techniques in use.

It is not possible to make broad comparisons between the automated steel plants in Soviet countries and those in the West without comparing technical details or technical papers completely. For example, the official Russian translation of W. E. Miller's IFAC paper termed hot strip mill automatic gage control as computer gage control.

SOVIET APPROACH TO ENGINEERING AND DEVELOPMENT

The assignment of engineering manpower in Soviet countries is based upon an evaluation of the long term relative economic worth of each industry. In the Soviet world, the iron and steel industry (Soviet metallurgical industry) is probably the most important. Of the 2000 engineers and technicians in the Institute of Automation, Kiev, 1700 are graduate engineers. Of these, 600 work on process and system development and design problems in the metallurgical industry. Current plans call for the early addition of 400 more to the staff, all in the metallurgical industry field.

Engineers working on process and systems for the metallurgical industry seem to have considerable academic freedom in their work. In the Institute of Automation and Telemechanics, Moscow, there appeared to be a number of engineers assigned to study the sintering process with considerable liberty in the scope of their investigations and their basic approaches. They read many of the technical publications and individuals voice varying opinions on the technical and practical value of this published material and the engineering approaches covered.

After an evaluation of the published material, additional or original work is done to define the process mathematically and computer simulations are developed. Control approaches are synthesized and defined mathematically. The principles are tested with working models. The models are checked in conjunction with the process simulation and the complete process system performance is determined.

Where several approaches are possible and when engineers differ in their choice of the one to be applied, all methods are apparently investigated simultaneously by a number of engineers. If all goes well, the study and results are turned over to the Institute of Automation, Kiev, for design and testing of a prototype. If tests are successful and the system is selected for use, it may be produced in quantity in a manufacturing plant and applied throughout the Soviet steel industry.

THE SOVIET ENGINEER

The average Soviet engineer shows a thirst for engineering contact with the Western world. They read foreign technical journals regularly. They were very well prepared for the technical meetings and considered the entire proceedings seriously and professionally. Their interest in visiting foreign engineers and installations appears to be more for the purpose of gaining technical knowledge rather than satisfying their curiosity as to how the Western world lives.

BASIC DRIVE SYSTEMS

Basic drive systems indicate an integration of knowledge of practices in the U. S. and Europe.[1]* For example, the present standard practice for reversing hot mills is to use a synchronous motor-generator set regardless of drive size. Power peaks are not considered to be a problem. Excitation for all d-c machines and the synchronous motor on the motor-generator set is by excitron mercury arc rectifiers. Rectifiers are single anode above 300 amp and multi-anode below this. All rectifiers are water-cooled except the very small ones.

The Soviet engineers said that their drive system selection was based upon their over-all economics much as it is in the U. S. and in Western Europe, rather than any special technical preferences. Large reversing rectifier drives are indicated to be uneconomical.

The basic electric system on other drives was essentially the same as in the U. S. or Western Europe. Hot strip finishing mills are supplied by individual rectifier power supplies controlled by speed regulators working through rectifier voltage. Main drive motor fields are excited by rectifiers. Tandem cold strip mills utilize individual d-c generator power supplies.

AUTOMATIC REVERSING HOT MILLS

At the meetings there was considerable interest in automated reversing hot mills. The impression was that Soviet engineers were now engaged in optimizing the production of such mills. It appeared that they were not entirely satisfied with the production level. The impression was obtained that the production level of the automated mill did not equal that obtained with operators. The number of engineers engaged in the discussions, both asking questions and listening, indicated that considerable importance was attached to this subject.

Experiments in automatic operation have been proceeding since 1954 according to an article published in *Elektrichesto* (USSR) in December, 1955. The particular complex automation system described involved complete modernization of auxiliaries, the addition of screw-down programming and an automatic operation utilizing photoelectric relays. A screw-down system utilizing transformer type simulator and feedback selsyns geared ten to one was described.

While the mills in the U. S. today are much more highly automated, those existing in 1955 utilized only preset programming, and did not incorporate sensors for automatic reversal.

No complete description of the modern Soviet programmed screw-down system was offered. However, the following comments were heard.

There is one digital system on a structural mill, although selsyn systems are generally used. Much work is now being done on digital approaches with thyrite memory. It was stated that they now prefer nonfixed programs in the USSR; no explanation was given.

Sideguards and manipulators are direct driven by large slow speed d-c motors. Positioning systems based upon selsyns are being developed for automatic operation.

Coded sensors and sample data systems have been developed for positioning systems.

Transistorized photoelectric relays are being used for

* Numbers in parentheses refer to Bibliography at end of paper.

TABLE I
Symbol Definition and Item Identification

CC1, CC2.....	Commutator control and determination of lengths of rolled sections of billets
CC1′.....	Compensating computer
CC2′.....	Correcting computer, for optimizing the parameter of CC1′
CMI, CM0.....	Input and output commutators of memory store, MS
FS.....	Following system
HC.....	Hydraulic capsules
IL.....	Integrating link
MC.....	System for control of motor, M
MS.....	Memory storage
Ph R.....	Photo-relay
RH0, RH1, RH2...	Recording and reading heads
RL.....	Block of regulating lay
SD.....	Summing device
SM.....	Stand motor
SP.....	Sensor of screwdown
STU.....	Set thickness valve of billets
TG.....	Tachometer-generator
TM, TM1, TM2....	Thickness meters
VR.....	Speed regulator for stand motor, SM
1.....	Screw-down motor
2.....	Screw-down regulator and power supply
3, 4.....	Thickness gage for deviation signal
5.....	Tensiometer for indication and range limit on last stand gage control
6.....	Stand main drive
7.....	Mill rolling speed reference
8.....	Stand 1 automatic gage control via screwdowns
9.....	Tachometer-generator
10.....	Automatic gage feed forward circuits, equivalent to RL in Figure 3
11.....	Automatic gage control circuit adjusting speeds of last stand and tension of the winding reel.
12.....	Winding reel drive
13.....	Automatic gage compensating circuit
14.....	Programming system for screwdowns as a function of mill speed
15.....	Preliminary gage reference for stand 1 based upon information on the thickness variation of the hot band along the length
16.....	Sensor determining the presence of a welded joint and transmitter for changing mill rolling speed
17.....	Punched card containing information of thickness variation along the length of the hot rolled band

position checking and reversing hot mills.

It was mentioned that static control offered the advantages of fewer inputs, higher speed operation, better reliability and optimum dynamic performance.

HOT STRIP MILL AUTOMATION

Hot strip mill automatic gage control (Figure 2) was mentioned in one of the papers[2] presented, but there was no indication or discussion of any installations. Gage control over the main body of the coil is achieved through operation of the screwdowns. Screw operation is a function of variation in finish gage over increments of length and variation of bar entry temperature.

Tail-end gage correction is achieved through strip tension control by changing the set values of the motor speed regulators as has been done in this country.

The schematic diagram shows hydraulic capsule type roll pressure sensors. Signals from the roll pressure sensors and roll opening sensor are shown being summed and compared with the stand set thickness reference signal. The difference is indicated to cause operation of the screw-down drive.

However, the text of the paper made no reference to any such operation. During the discussion period a preference was indicated for noncontacting type thickness

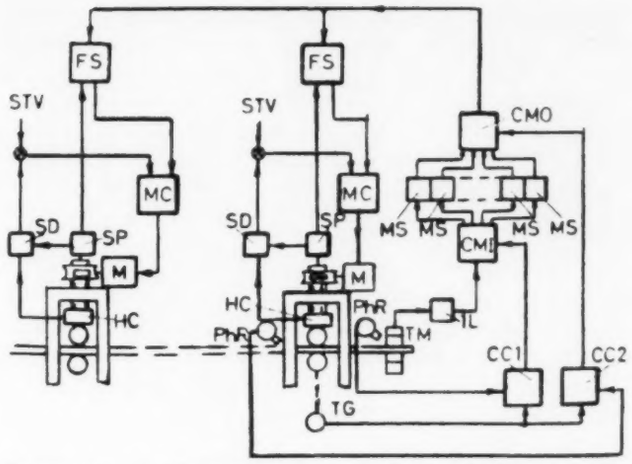


Figure 2 — A schematic of the hot strip mill automatic gage control is illustrated.

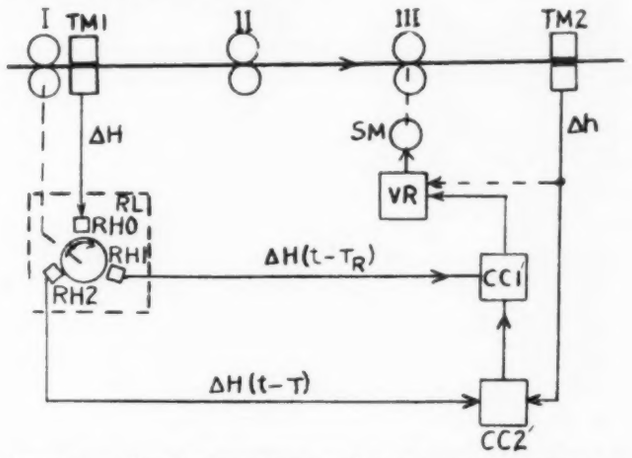


Figure 3 — Stand screwdown and stand speed control are utilized to control a 3-stand mill.

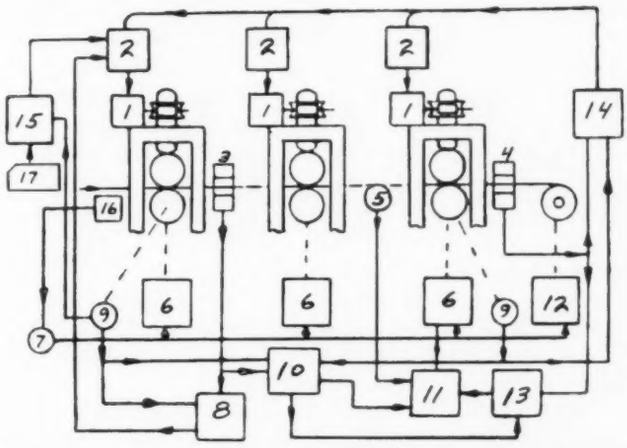


Figure 4 — A feed forward transport compensation changes stand 3 speed with relation to stand 1 gage error.

gages over roll pressure sensors. The impression was gained that the roll pressure sensors may not be used.

No mention was made of the ability of the system to correct for gage variations introduced by the cold spots due to furnace skids. The operation described in the paper would not provide correction. A significant advantage of the gagemeter (load cell) system used in the U. S. is its ability to smooth out gage variations resulting from these cold spots.

There was considerable interest in possible methods of measuring and automatically regulating interstand

tension in the hot strip finishing mill. It did not appear that this was being done on either a Soviet or any other hot strip mill.

Width gages are used on hot strip finishing mills. Optical-mechanical systems of good accuracy are claimed. Their claim is that a new gage based upon the "well known photo pulse" method has been developed with performance practically equal to the BISRA method.

It was stated that width variations in finished strip have been cut in half through observation of the width gage indicators. Development work is in progress on an automatic width control system utilizing a width gage. No statements were made regarding present width variations or expected improvement with the new system under investigation.

AUTOMATIC GAGE CONTROL—COLD REDUCTION MILLS

The Soviets have done considerable process and system analytical work on tandem cold mill automatic gage control. They proudly claim significant technical contribution. There is no doubt regarding their depth of analysis, their understanding of the process and system performance and the technical sophistication of the systems described.

One paper[3] describes an analysis, analog computer simulation and tests of the tandem cold reduction process and electric systems.

The characteristics of tandem mills and gage performance due to variations in drive system behavior and other rolling parameters have been studied.

A gage control system (Figure 3) for a 3-stand tandem mill is described in another paper[2] and an article[4]. This system utilizes stand screwdown and stand speed control. It consists of a combination of feedback and feed forward techniques. Gage is measured after stands 1 and 3. Stand 1 gage error is also fed forward to change stand 3 speed after a transport time. The feed forward transport compensation is by an endless magnetic tape. A change in the type of steel being rolled is said to require a change in gage control setup.

The complete cold strip mill drive system including automatic gage control is shown in Figure 4. The system shown is significantly more sophisticated technically and more complex circuitwise than systems used in the U. S. The system is undoubtedly capable of very good performance. However, the feed forward system introduces control complications that may not be warranted from a practical operating viewpoint.

Programming of screwdowns as a function of mill speed provides a function similar to the programming of stand speed ratios used on some U. S. mills. Programming of stand 1 screws from a punched card containing hot mill gage information can be used to reduce the range required in the stand 1 gage control. However, there have been very few cases in the U. S. where hot mill band gage variations were so great as to be a problem to the cold mill gage control. The widespread acceptance of hot strip mill gage control should eliminate any problems encountered.

There were no statements made regarding the extent of the use of this gage control system on tandem mills in the USSR. However, it was implied that equipment is in operation.

AUTOMATIC TESTING FOR SLAG INCLUSIONS

A unique equipment used to check for laminations and slag inclusions in metal slabs, plate and strip was shown and demonstrated at the Institute of Electrical Engineers, Leningrad. The equipment, as installed and being used in a Soviet steel plant, indicates defects as small as 0.155 sq in. in material up to 3.15 in. thick and up to 9.8 ft wide by 163.5 ft long. The complete test is performed, after rolling without any special surface preparation in 60 sec.

Professor Bogarodetsie, Institute Director, and his assistants explained that a 1.5 megacycle ultrasonic scanning system is used. As the plate or sheet is moved through a water bath the sonic beam travels across the sheet 50 times per sec just like a tv system. There are 300 detectors on the system installed in the steel plant. Intelligence is fed to a magnetic computer with a permalloy memory.

The test material is scanned twice, once as it moves forward, and then as it moves backwards. Two plots are obtained, one showing the plate to scale and the second only the defect. Then by superimposing the two plots the defect is easily located in the plate.

The same equipment may be used for ferrous or nonferrous materials since it operates on the basis of transmission through the sheet.

Equipment has been built to detect defects as small as 0.0155 sq in., but such accuracy is not necessary in a steel plant.

In the laboratory, the development equipment and the prototype, which was equivalent to a section of the equipment said to be installed in the steel plant, were shown.

Since mention of the Russian installation in *Steel* one or two articles have appeared describing steel product inspection installations of similar size and utilizing the same technical approach.

Professor Bogarodetsie explained that ultrasonic equipment using 2000-megacycle crystals has been built and is being used for checking densities of semi-conductors.

AUTOMATION OF OTHER PROCESSES

Electric drive and control systems for blast furnaces, billet mills, flying shears, reversing cold strip mills and furnaces were presented. While some of the systems described by Soviet engineers are not known to be installed in the U. S. or Western Europe, all systems could be designed if their use could be economically justified by the customer, i.e., one paper described a system for automatic cutting of billets into optimum lengths determined from a calculation of the thoretical weight of the bloom after cropping. Such systems have been considered in the U. S., but no one has justified their purchase so far as is known.

One East German paper described plans for automating a blooming mill, including the soaking pits, with punched card programming. However, it stated that the automation was not scheduled to be carried out until 1964.

Another East German paper started with the following statement: "Based on the economic agreements made between the socialist countries, the GDR (East Germany) has been allotted the task of development and

construction of all types of continuous rolling mills as well as cold strip and foil mills. The solution of the problems involved is not confined to the mechanical sections of said equipments but includes the entire electric equipment as well. In this way, the entire field of heavy reversing mills with their highly specialized and complex driving and regulating problems does not form part of the scope of work to be covered by the GDR." Notwithstanding this, the paper on automation of a blooming mill which was mentioned was written by an East German.

INSTITUTE OF AUTOMATION AND TELEMECHANICS

The Institute of Automation and Telemechanics, Academy of Science, Moscow, is responsible for research and development in the various branches of automatic control. It is divided into a number of laboratories, with a total staff of slightly less than 400 engineers. Some of the laboratories are: automatic pneumatic and hydraulic control; self-adaptive or self-adjusting systems; optimizing; predictive and optimizing systems; machine tool programming; magnetic amplifiers, relay and contact systems; telecommunications or telemechanics; and components.

The sources of requests for development work come both from industry and from the Academy of Science. Significant attention is being devoted to the development of means of automatic optimizing of system design and of system performance. A number of automatic optimizers were demonstrated or shown, including an electronic optimizer capable of 12 channels and four constraints and said to be able to optimize a third order model in seven min. It was claimed that a complicated 100 variable system could be analyzed in two hr.

KLEMENT GOTTWALD STEEL WORKS

The Klement Gottwald Steel Works is the most modern mill in Czechoslovakia (Figure 5). It was founded in 1949, and the first blast furnace went into operation in January, 1951.

Its present production of pig iron is 4800 tons per day in four blast furnaces, each 22.9 ft in diameter. They produce 7500 tons per day of coke in eight batteries. Ultimately, there will be ten coke batteries.

There are eight open hearth furnaces, four of 200-ton capacity and four of 400-ton capacity. They now produce 2,000,000 tons per year and ultimately plan to have a capacity of 2,800,000 tons.

Figure 5 — The Klement Gottwald steel plant employs 21,000 people.

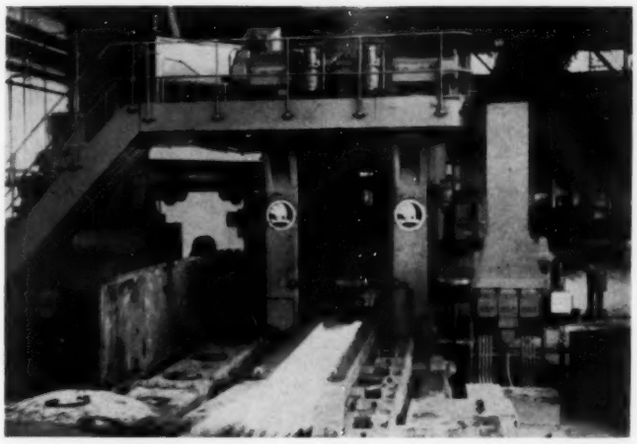


Figure 6 — The blooming mill electrical and mechanical components were built in Czechoslovakia.

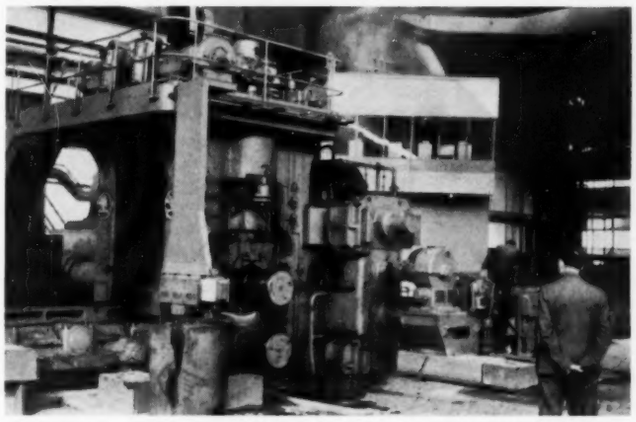


Figure 7 — The operator directs the bloom passes from an enclosed pulpit on the entry side of the mill.

The mills that are in operation, some of which will be described, are:

1. Blooming mill, another is being built, see Figures 6 and 7.
2. Billet and wire rod mill.
3. Cross country mill.
4. A 9.84-in. skelp mill.
5. A 31.8-in. hot strip mill.
6. Two tube mills.

There is also a forging plant and a foundry.

The mill employs 21,000 people, 3500 of whom are technicians and scientific people. The average age is 29, and 26 per cent of the employees are women. There are 36 doctors in the plant.

Between 1958 and 1960, the number of employees reportedly doubled and production was tripled.

The ore used is partly Czech and partly Russian.

The plant generates its own power in a station of 60 to 80 megawatts capacity.

Electrical equipment in the plant is mostly Skoda (Czechoslovakian) with some Swiss, Italian and others.

CONTINUOUS WIRE ROD MILL

The continuous wire rod mill rolls 0.1968 to 0.3937-in. wire rod from 2.36 x 2.36 in. by 38-ft long billets. The billets go to a reheat furnace, then to the 4-strand,

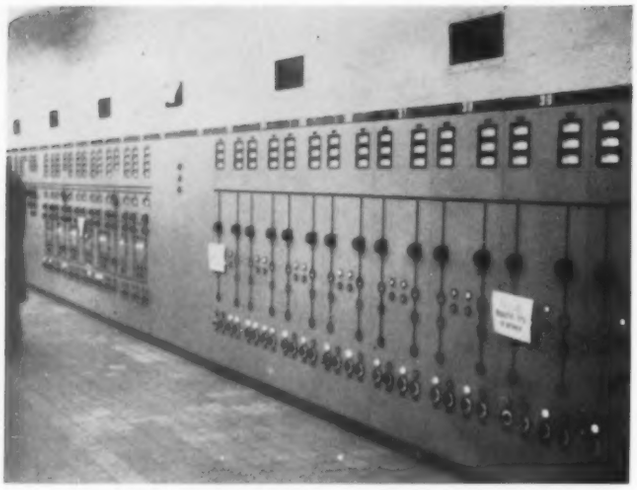


Figure 8 — The rectifier powered wire rod mill has a modern supervisory control room.

39-stand mill. It consists of seven roughing stands, followed by a flying shear, two groups of four intermediate stands and four groups of six finishing stands, each latter group consisting of three vertical and three horizontal stands.

The main drive rectifiers and controls were furnished by Berlin Treptow (East Berlin) (Figure 8), the motors by Skoda, the transformers by a West Germany firm (because of shipment problems from East Germany) and the auxiliaries are Czechoslovakian.

The mill operates at finishing speeds up to 5900 fpm. At the time of the visit the mill had been in operation for only two weeks.

CROSS COUNTRY MILL

The cross country mill produces 1.968 to 4.33-in. rounds, plus I-beams, channels and angles at finishing speeds of 600 to 1500 fpm.

The mill includes five roughing stands, three intermediate stands and one finishing stand. Five stands have 1000-kw motors and four have 700-kw motors. The mill is powered by motor-generators sets, common bus, using rotating speed regulators working on motor fields.

The hot saw is powered by an induction motor. Maximum finished length is 196 ft.

SKELP MILL

The skelp mill has 15 stands (including four edging stands) (Figure 9). The four finishing stands are 4-high, each driven by a 900-kw motor.

The mill is powered by two 4400-kw synchronous motor-generator sets, operating at 500 volts, with 50-volt boosters on each drive motor.

The maximum finishing speed is 2350 fpm, with thicknesses of 0.0787 to 0.1968 in., see Figure 10.

HOT STRIP MILL

This mill is so new that it was not yet commissioned at the time of the visit, although it was in operation on a part time basis (Figures 11 and 12).

The mill consists of an 800-kw induction motor driven scalebreaker, 2600-kw reversing rougher with 45-kw edger, and six finishing stands. Stands 1 and 6 had 1300-kw (1750-hp) motors, and the intermediate stands had 1600-kw (2150-hp) motors. An edging stand driven by two 75-kw motors is located between finishing stands 2 and 3. Top delivery speed is 2150 fpm.

The hot strip mill and all the other rolling mills had separate motor rooms and the customary Western European supervisory control room with meters, recorders, circuit breakers, etc. (Figure 13).

The mill was powered by motor-generator sets since, it was explained, Czechoslovakia does not yet have enough experience to use rectifiers on such a mill.

Each roll on the runout table was driven by a separate 1.8-kw synchronous motor operating in an adjustable frequency system, see Figure 14.

FORGING PLANT

The forging plant, installed in 1952 to 1954, has a 12,000-ton press built by Skoda (Figures 15 and 16). This is reported to be the largest press in Europe, outside of the Soviet Union. By the comparison of the Czechoslovakian engineers, the U. S. has one 15,000-ton press, Russia has one 15,000-ton press, and Japan has two 15,000-ton presses.

The press is used primarily for producing hollow chemical vessels and turbine generator rotors.

GENERAL COMMENTS ON THE KLEMENT GOTTWALD STEEL WORKS

The mill was new looking and clean, as it should be considering its actual newness. Generally, it appeared

Figure 9 — The last four stands of the skelp mill are 4-high.

Figure 10 — Skelp mill maximum finishing speed is 2350 fpm.

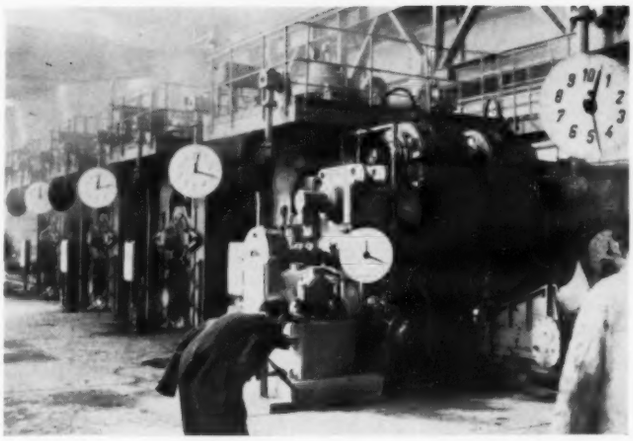


Figure 11 — An edging stand is located between mill stands 2 and 3 of the hot strip mill.

Figure 12 — Strip mill maximum delivery speed is 2150 fpm.

relatively modern and well built. However, from a drive system and automation standpoint, it is actually not modern by present U. S. standards. For example, in addition to the points already mentioned, all regulators are of the rotating type; there were no magnetic amplifiers or transistorized controls in evidence. There were no rectifier drives except for the wire rod mill. No digital equipment appeared to be in use.

While this mill is nearing completion and will soon be up to its rated capacity, a new steel mill, twice as large is to be erected. This will be the largest single project undertaken in Czechoslovakia since the war. It will be built with Soviet technical aid on the eastern border of the country, within easy access to Russian raw materials.

BHILAI STEEL WORKS

The Indian Government owned and operated steel plant at Bhilai, India, was financed, designed, constructed and placed into operation in January, 1960, by the USSR. Although not visited by either of the authors, a first hand account was given by a West German engineer. Additional data on this or a very similar mill were taken from a Russian paper.[1] (Russian papers almost never identify locations of equipment described). This is reportedly the third such mill the Soviets have built.

During construction of the mill the Russians had approximately 200 engineers on the job, plus 400 to

Figure 13 — The motors for the hot strip mill were in a separate room and the supervisory controls were enclosed in a room within the motor room.

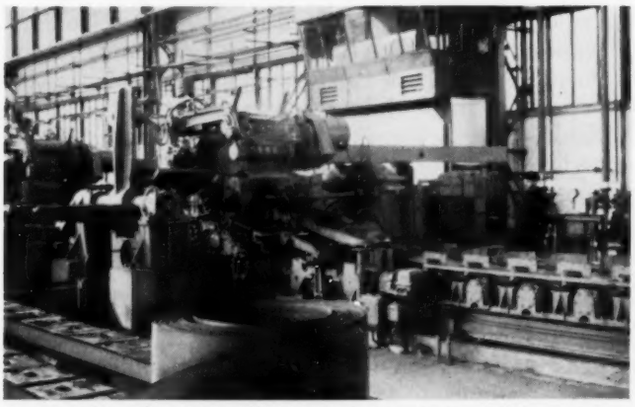


Figure 14 — The hot rolled strip is banded on either of two upcoilers.

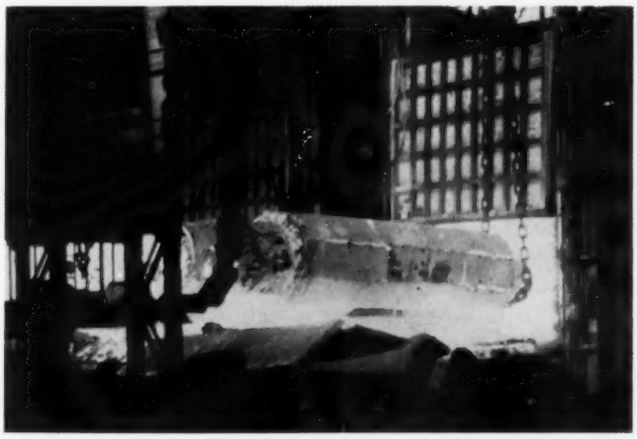


Figure 15 — The ingots are heated to forging temperature in large furnaces.

Figure 16 — The 12,000-ton press is the largest in Czechoslovakia, if not in Europe.

600 skilled laborers for supervision of construction and erection and 15 interpreters. In addition to building the steel plant, they built a complete city for 100,000 people. In the opinion of the engineer the Russians sent only first quality engineers to India. They have learned how to explain operations to very unskilled operators. The Russian engineers watch the Indians operate the mill, and correct them when they make a mistake.

The mill has a capacity of 1,000,000 tons per year of profiles, rails and merchant bars. The plant includes:

1. Two sintering lines.
2. Three coke oven batteries.
3. Three blast furnaces.
4. Six open hearth furnaces.
5. A 45.3-in. blooming mill.
6. A 19.6 to 27.6-in. continuous billet mill.
7. Semi-continuous 13.8-in. merchant mill.
8. A 37.2 to 31.4-in. rail and girder mill.

The open hearth shop, which is not modern looking, is reportedly the largest in Asia in size, but not in production. Six furnaces, each of which produces 500 tons per melt in a 13-hr melting time. They plan to introduce oxygen blowing to reduce the melt time to seven hr.

The blooming mill was reported to be impressive, of modern appearance and with an air-conditioned pulpit. The manipulators are direct driven by a 300-kw, 60-rpm motor.

The auxiliaries throughout the mill utilize rotating regulators which appear to be identical to American designs. There were no magnetic amplifiers. The control equipment was very simple and similar in appearance to older American equipment. In general, all the equipment appeared to be built for reliability and low maintenance.

THE PRESENT AND THE FUTURE

On an over-all basis it is felt that the Soviet engineers acknowledge U. S. leadership today in automation systems for iron and steel processes. However, practically all of these engineers are convinced that they shall pass us in steelworker productivity and steel product quality at some future date. They are convinced because they have confidence in their ability as engineers, and because their government has set this goal for them and supports them in achieving it.

The impression was that Russian engineers are skeptical that free enterprise and free competition can produce the funds necessary for the level of research and development they envision. However, in the U. S. research and development is more efficient, more highly automated, more productive in the advance technologies and more productive in the application of these advance technologies to industrial processes.

Unfortunately, a period of low steel operating rate could cause a significant reduction in steel plant expenditures for process and operating improvements which in turn could cause a corresponding reduction in funds available for development of advance process and electrical technology.

On the other hand, free world competition, both domestic and foreign, is keen. There is a constant search for improved cost control, quality control, production control and profit realization to provide for future improvements. There is an awareness that the advance in technology makes possible a degree of process automation with a substantial level of realization of all these benefits even at today's operating rates. Automation based upon sound planning can pay off, and this payoff can generate the funds necessary for the continuing research and development.

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Washington Student Awarded AISE Merit Scholarship

An Association of Iron and Steel Engineers Merit Scholarship has been awarded to Dean Hideo Uyeno of Walla Walla, Wash. Mr. Uyeno, who won the scholarship in nationwide competition, plans to attend the University of Washington and study engineering.

DEAN UYENO

The AISE Merit Scholarship Award was begun in 1955 and is a part of the Association's continuing program of educational activities. This program also includes special publications, various lecture courses, and research work on selected problems in steel plant engineering.

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Last year's award winner was David S. Evans, of Beaver Falls, Pa. He is currently attending Massachusetts Institute of Technology.

Open Hearth Improvements for Optimum Results Using Oxy-Fuel Burners and Oxygen Lances

by WILLIAM A. VOGT,
Consultant,
Lafayette, Calif.

. . . . roof charging of open hearth furnaces can greatly shorten charging time thereby permitting more economical use of tonnage oxygen . . . .

THE use of oxygen in open hearth steelmaking is increasing rapidly, apparently following the pattern set by the oxygen converter. Considering the vast difference in the metallurgy of the converter and the open hearth, it would seem greatly advisable to reappraise the situation carefully, at this time, in order to see clearly what can be expected from each process and what the operational differences are.

The oxygen converter is a clearly defined metallurgical process. In a practically closed vessel a certain volume of hot metal of a known analysis is to be refined to steel: nearly all the silicon, manganese, phosphorous and carbon in the hot metal have to be oxidized. This process requires a calculable volume of oxygen. If the hot metal analysis is uniform from day to day, the same volume of oxygen would be required and the same blowing procedure would be used. Usually there is an excess of chemical heat in the impurities of the hot metal which, when released during the oxidation, would have the tendency to overheat the charge. To absorb the excess heat, a cooling agent, scrap or ore, is added in predetermined volumes. This looks like a very simple and clearly defined metallurgical operation.

Compared with the converter process, the open hearth operation is much more complex mainly due to the fact that the operator has to melt a high percentage of scrap and also carry out the refining process of the hot metal charge. The use of oxygen for the refining of hot metal will be somewhat the same regardless of whether it is done in the converter or in the open hearth furnace. The most economical use of oxygen for the scrap melting process in the open hearth furnace is a current objective. This process is of great interest to the steel industry, for done correctly, it can accomplish outstanding results. However, it can waste oxygen and cause economic losses if done incorrectly.

There are several ways of using oxygen in open hearth furnaces. The most obvious one would be to add oxygen through the end burners. This would have the effect of raising the flame temperature at the tip of the end burner, resulting in a generally higher furnace temperature. This could be achieved without oxygen by simply using bigger end burners. However, the use of oxygen has the advantage that it will not increase the volume of combustion gases. The increased furnace temperature would increase the radiation from roof and walls, and thereby speed up melting of the scrap charge in the furnace. Oxygen added to the combusion at the end burners must be limited, as over-all higher furnace temperatures will shorten the life of the refractories. However, the application of oxygen at the end burners is a very important help to the operator, although the volume of oxygen used at this point will always be comparatively small.

Besides the use of oxygen in the combustion at the end burners, the new open hearth process uses oxygen lances for the refining of the hot metal. The same volume of oxygen is required to refine a given volume of hot metal of known analysis, whether the process takes place in a converter or an open hearth furnace except, maybe, for some losses from increased bath agitation.

The most important results from the use of oxygen in open hearths can be gained from its application in individual burners during the scrap melting period. The real advantage of the oxy-fuel burners lies in the fact that their flame can be directed right at the scrap pile without first heating the whole furnace. It is this localized application of oxy-fuel burners to apply additional heat just where it is needed which offers the

economic answer to the search for increasing production by the use of oxygen. Oxygen is an expensive item and economically apparent results must be produced to justify its use.

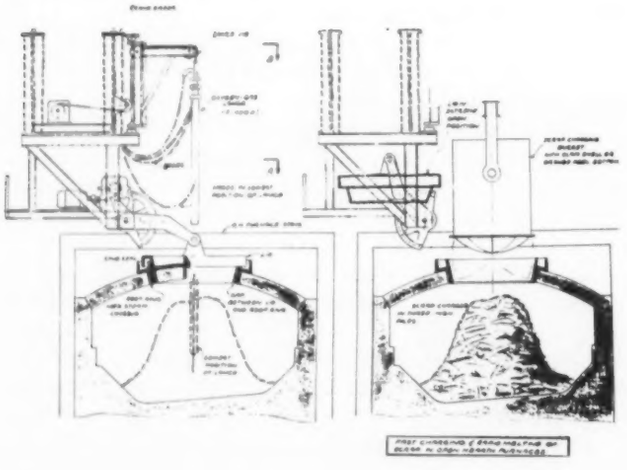
A careful study of test results related to the use of oxygen in the U. S. open hearth furnaces and also from a number of foreign countries shows that the margin of cost improvement is so small that one must have at least a 25 per cent increase in production to break even under the present conditions of open hearth design. Furthermore, all the reports are unanimous in making one point: the charging time must be shortened before one can expect to get full value from the volumes of oxygen used in the open hearth process. With a charging time of three hr, the benefit from the use of oxygen may be easily cancelled by greater heat losses. With charging times of four hr and more, no economic advantage can be achieved over the cost of the oxygen consumed.

This indicates that efforts should be concentrated on straightening out the most obvious shortcomings in the present setup and procedures. The results so far point out that the melting of steel can be speeded up if the scrap is brought into close and direct contact with increased burner heat, and if the scrap charging time is shortened. The long charging times are a cause of considerable heat losses.

Changes have to be made, if improved performance is to be obtained without sacrificing the reliability and flexibility of the open hearth process. The changes that seem most urgent must be determined. The design of the conventional open hearth furnace has not markedly changed since 20 years ago, when the sloped backwall was introduced to make the upkeep of the furnace easier. It is felt that this change for the sake of operations has been overdone in the following years and that the redesign of the furnace cannot progress any further in this direction.

The width of the furnace roofs and their weight seems to have arrived at the very limit. However, this is a subject for a lot of argument, but this is why it is felt that the steel industry is fortunate that in the meantime the change from acid to basic refractories came about. Basic refractories permit freer design changes.

Figure 1 — The covers for the roof charge openings each have a center opening to permit insertion of an oxy-fuel lance.



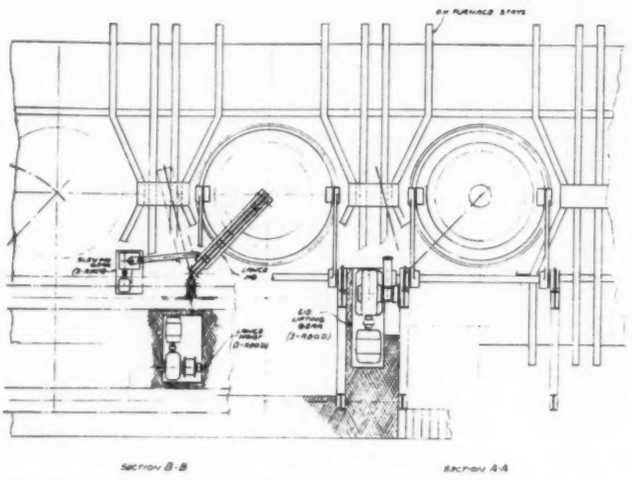


Figure 2 — The furnace roof between knuckles could be divided into three sections, each one having a roof charge opening.

The fully suspended roof will give the furnace designer a free hand. It is felt by some that the furnace roof should not be wider than the furnace hearth.

There is, of course, the German Maerz-Boelen furnace which has a roof width even narrower than that, which is remarkable and certainly should be given full consideration, especially since the furnace performance is reported to be excellent.

However, for the immediate future preference should be given to the great number of furnaces which will be idle due to the fact that the oxygen converters have taken over part of their production. The present recession in business presents the opportunity to investigate and develop engineering answers and approaches for improvements to the open hearth.

From the above analysis of the situation, it seems that for more efficient scrap charging a method which would deposit the scrap in the furnace in direct reach of the oxy-fuel burners installed through the roof is most desirable. At the same time this new system would have to make it possible to shorten the charging time to an absolute minimum.

The top charging method as it has been used for years in connection with electric furnaces is a system which meets these requirements. This system cleverly applied to the open hearth furnaces would fulfill all of the requirements for efficient charging: the charging time would be reduced and the scrap would be deposited in a conical pile on the very center line of the oxy-fuel burners. An additional advantage would be that the charging time would become independent of the capacity of the furnace, simply by dimensioning the equipment in relation to the furnace capacity. The standard charging time of open hearth furnaces designed for this type of top charging method would be approximately one half hr.

It is surprising that there should have existed such an ideal solution for the open hearth charging needs without attracting serious considerations through all these years. However, the development of the design of the open hearth has prohibited any designer from changing the furnace roof, for only in the last few years have such changes become feasible, with the introduction of the suspended basic roof.

The installation which it is felt would give a satisfactory answer is shown in Figures 1 and 2. There seem to be no design difficulties which could not be solved by intelligent engineering.

The first design change probably would be to divide the length of the active furnace roof into three self-sustained sections by introducing skew backs, running on the dividing lines from front wall to back wall. With this the long roof is eliminated and the problem would be reduced to bricking out the squares toward the heavy cooled rings inserted in the charging openings. From Figures 1 and 2 it can be seen that the weight of the large covers, which close up the charging openings, will not rest on the roof but will always be supported by the levers of the independent cover-lifting mechanism. The movement of the cover-lifting mechanism should be entirely free of vibration and the cover itself should at all times stay in the horizontal plane.

The furnace should have three roof burners, and the number of furnace doors could be reduced to three. This reduction would improve the furnace by reducing air infiltration.

The scrap charging cycle would be: The scrap buckets (wider at the bottom than at the top to avoid wedging of scrap) are brought to the furnace on special cars on the scrap track along side the front wall of the furnace. The overhead crane engages, the cover is lifted off and the scrap is deposited through the charging opening. If the scrap buckets are placed on special cars, properly positioned, the charging can be accomplished mainly by trolley movements. After the covers have been replaced, the combination burners can be lowered and melting can begin.

Although Figures 1 and 2 show some ideas in regard to the redesign problems, these are not the only ones. For this reason these suggestions are offered as a challenge rather than as a complete engineering solution. The main necessity is that somewhere a furnace should be rebuilt for top charging, in order to establish definitely what such a system can do. If results indicate that the charging time can be tremendously reduced as claimed, acceptance of the system will be a matter of economic application. Any other suggestion which fulfills the established requirements should also receive open-minded consideration. The only goal is to find the answer at this time, which happens to be favorable for drastic changes, for radical changes will have to be made if the steel industry wants to be able to use oxygen more economically in its open hearth furnaces. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer* a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those of primary interest to the American steel plant operator. The papers may be obtained from the British Iron and Steel Industry Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W. 1, England. All correspondence concerning price, ordering and so forth should be directed to that address.

1492 KAHLHOFER, H., et al.: "The Effect of Pretreatment of the Charge in Blast Furnace Operation," *Stahl u. Eisen*, 1959, Oct. 15, pp. 1461–1471. Step-by-step procedure for the pretreatment of a charge with 28 per cent Fe sinter and 3 per cent Fe screened minette. Screening of Swedish lump ore and Venezuelan ore and sintering of fines under 10 mm. Comparison of operating data from different experimental stations. Heat balance. Results compared with those from normal operation. Economics. (Author's summary.)

1566 KRAUTKRAMER, J.: "Ultrasonic Determination of the Size of Defects," *Arch. Eisenhut*, 1959, Nov., pp. 693–703. Proposals for the standardization of ultrasonic data using echo height for drawing up standard series and specifications for comparing small defects with artificially induced defects of given sizes. Free choice of instruments, probes, frequencies and a reference plate cut from the same material as the test piece. Determination of defect size in the near and far field. Use of special probes for the near field. Allowance for the influence of curved surfaces. (Author's summary.)

1652 KNUPPEL, H., and G. WEITHOFF: "Electronic Crane Weighing Scales for Use in Iron and Steel Works," *Stahl u. Eisen*, 1960, vol. 80, Feb. 18, pp. 220–233. Circuits and other arrangements are shown and uses in materials flow control are noted. Pressure cells are more suitable than tension cells for the purpose and details of a successful installation using the former are given. (Abstract preprinted from *JISI*.)

1665 MORISHIMA, T.: "Study of the Hot-Workability of Steels," "Hot Working Properties of Austenitic Stainless Steels," *Tetsu to Hagane*, 1956, Sept., pp. 928–930. The effects of oxygen content on the hot-workability of 18-10 and 18-12 Mo stainless steels at 1100, 1200 and 1300 C, and of S, Al, Ti, Cu, P, N_2, C, Ni, Mn, Si, Cb, and Mo on the hot-workability of 18-10 steel at 1200 C are discussed. (Abstract *JISI* 1957, July p. 378.)

1716 HEYNERT, G., et al. "The distribution of the burden within the blast furnace and some possibilities of exercising an influence on it," *Stahl u. Eisen* 1960, April 14, pp. 473–483. Fundamental investigation into burdening phenomena. Experiments on a blast furnace model 1:20. Test on a charging model 1:1. Application of test results to blast furnace operation. Burdening without material segregations. (Author's summary.)

Production Aspects of the Dwight-Lloyd McWane Ironmaking Process

by HAROLD E. ROWEN, Vice President, Dwight-Lloyd Div.
and C. D. THOMPSON, Assistant to Director of Research, McDowell Co. Inc., Cleveland, Ohio

. . . sintering prereduction and submerged arc smelting can be combined to produce an economically efficient operation meeting exacting analysis requirements . . .

A DOZEN years ago McWane Cast Iron Pipe Co. and its subsidiary, Pacific States Cast Iron Pipe Co., were unable to secure sufficient pig iron of the analysis required for their product when industry demands were high, and were unable to secure the iron at all times at costs which would enable them to remain competitive. McWane could have built its own blast furnace to produce iron but it was felt that the comparatively modest requirements might not secure a good return on the investment, particularly when the costs of purchased or self-produced metallurgical coke were considered.

A long-range research program to make complete studies of all the reactions required to produce iron from ores, fuel and flux was assigned to Battelle Memorial Institute. The assignment further called for development of a method of smelting which could produce the required comparatively low tonnage per day of iron, meet the exacting analysis requirements of the foundry and remain in the production cost range of the competing large blast furnace.

The studies indicated that a fast, low-cost partial reduction of the ore at lower-than-smelting heats could be combined with a fast, low-cost final smelting operation at high heats in such manner that a total integrated operation could be carried on continuously or intermittently.

Exhaustive examinations of techniques known and reported to be under test for the prereduction stage were made. These resulted in rejection of those which required special atmospheres, precise regulation of temperatures to avoid unwanted agglomeration of fines while passing through plastic stages, thermal shock which resulted in spalling, attrition and crushing of the pellets through tumbling or rolling during treatment, or long periods of residence which would defeat a desired fast prereducing treatment to permit fast corrections of burden in the final furnacing. Careful consideration was given to permissive intermittent and continuous operation with minimum maintenance and stand-by expense.

Research, bench work and bench and pot tests followed by prototype pilot campaigns were thorough and successful and resulted in a basic U. S. patent issued in the name of Samuel L. Case, and other patents, U. S. and foreign, granted or pending.

Early recognition of the same type of problems for which the sintering system had provided the answer, benefits of which are so apparent in modern blast furnace practice, was made.

The research team was fully aware that the modern blast furnace has for many years, does today and will in years to come, carry on all the phases of producing metal: drying, heating, calcining, prereducing and smelting of a layered charge of metallurgical coke, ore and flux materials as they descend in the stack. They also knew their sponsors could not absorb the large tonnages an economical blast furnace must produce, were not interested in the large capital investment required and that the unit could not be operated inter-

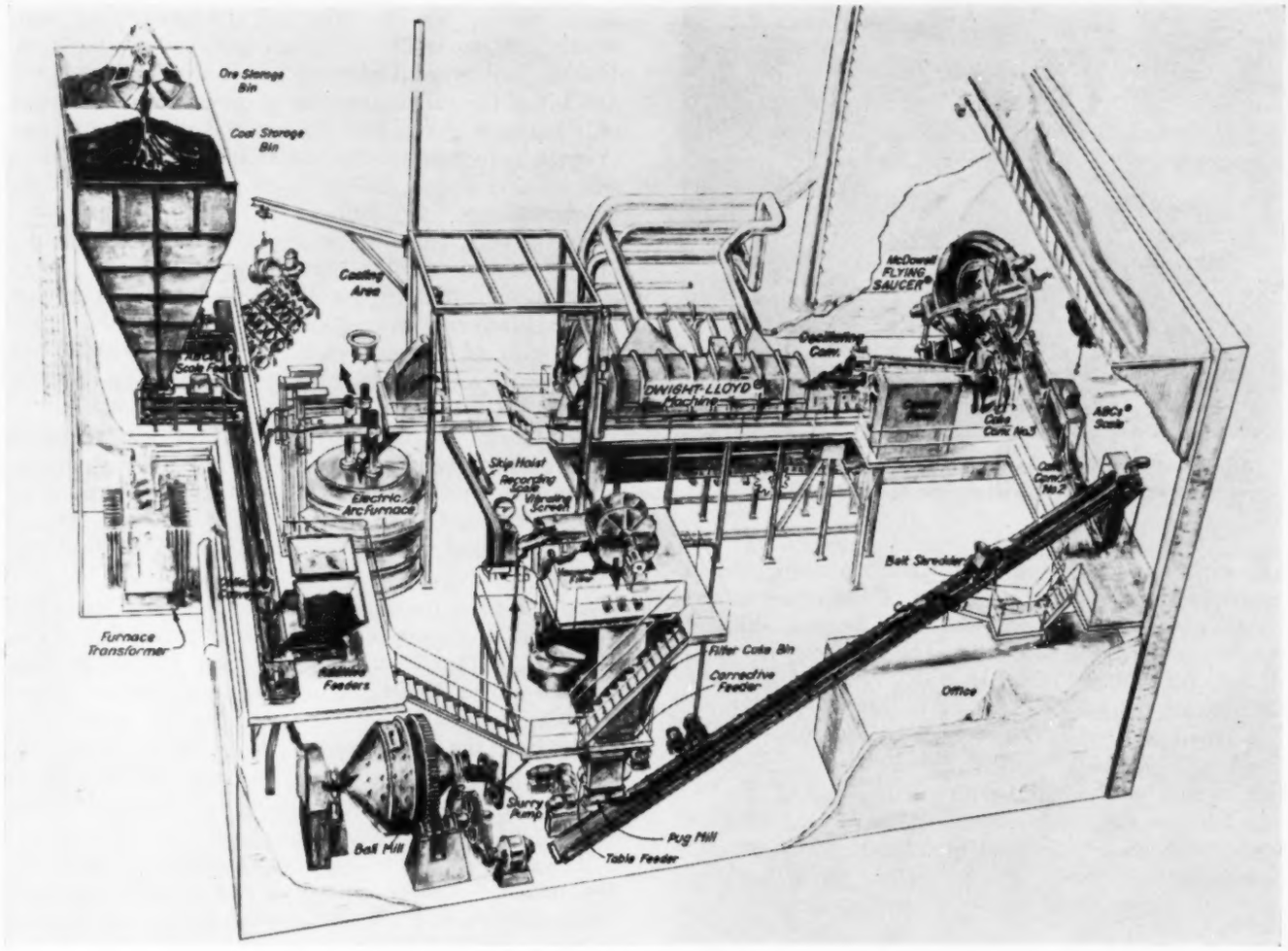


Figure 1 — Plant flow permits three basic methods of initial feed preparation.

mittently or economically with constant changes in product analysis.

It is not within the scope of this article to describe what occurs in the blast furnace stack beyond an assumption that about half-way down the charge is in the 1700 to 1800 F. temperature zone and will have been dried, calcined, heated, partially prereduced and ready to enter smelting heats, about four to five hr after being charged.

The adviser found particular interest in the development, for in his records appeared four U. S. patents applied for in 1910 and 1911. These patents taught the use of a separate, comparatively-low-temperature vessel for drying, heating, calcining and partial prereduction of the charge to present a hot pyro-beneficiated burden directly into the melting furnace. Hot sinter was discharged into both carbon-fuel-fired and electric furnaces, after being subjected to normal sintering gases and the passage of hot CO gases.

The patents taught the benefits of sintering the fluxes into the furnace charge for calcination, and the final use of both blast and electric furnaces. However, they did not teach the creation of a char-coke bond during beneficiation.

The determination of McWane and the background of the engineering concern involved, created an impetus for the pilot processing of many ores and coals which has been conducted for the last four years in a research laboratory at Cleveland, Ohio.

This prereduction, smelting method is an ingenious process which has been developed through utilization of a combination of common equipment units, which are in general use in the iron smelting industry; and a process which completely avoids the use of reactors requiring high temperatures, pressures, precisely-controlled atmospheres, or exacting control of heat zones once believed essential to so-called prereduction arts.

The plant flow sheet (Figure 1) permits three basic methods of initial feed preparation:

1. The ore, coal and fluxes are already fine enough so that they may be simply proportioned into the charge stream.
2. One or all of the components may require further grinding, which may be done dry.
3. One or all of the components may require further grinding, with wet grinding and filtering deemed desirable.

Starting with the bins shown in the upper left corner of Figure 1 the flow of material can be seen without further identification as to location.

Crushed ore and noncoking coal (ordinary steam quality) are fed from the bins by means of belt feeder scale controls. The desired fluxes are added to the burden belt which discharges them into a ball mill where they are ground and mulled into an intimately-mixed pulp of the desired particle size range. The pulp discharges to a pump which forces it up to the filter.

Figure 2 — The ability to produce uniform pellets at all times assures optimum production operations.

The filter is mounted on top of a feed surge bin. The surge capacity of the bin permits a single control point for the feed to the balance of the process. Provisions are made to by-pass the bin if desired, although this has never been necessary. The bin feeds the main charge belt, with close quantity control available through an adjustable gate and feeder speed.

A small nest of auxiliary bins in the surge unit is fitted with quantity-control feeders permitting addition of any of the components of the feed if the fast quantitative and qualitative methods of analyzing the feed stream, pellets and hot metal detect any deficiencies. The flow sheets permit these "sweetening-up" additions to be in the smelting furnace within 15 min and assure that the final product (hot metal) will be of the desired analysis.

The proportioned charge burden proceeds up the inclined belt where it passes through a fluffing unit. This treatment of materials to be pelletized is not always required but is beneficial in overcoming any packing which may have occurred in the surge bin. The fluffer is a simple assembly consisting of rapidly-rotating cross blades which pick the charge from the belt, aerate it, and throw it forward onto the belt in a discrete particle fluffy bed.

A cross belt, which is fitted with a recording belt scale, carries the material to the pelletizing unit, which assures uniformly sized pellets at all times. During pilot runs an operator has control of both speed and tilt of the pelletizing pan, of moisture addition and of the exact point for placing the mix in the pan (Figure 2) to generate data so that process engineering will be able to provide optimum production operating characteristics.

Figure 3 — Prereduction in a sintering machine produces pellets for direct charging into the submerged arc furnace.

The pellets, each containing the desired quantities of fine ore, fine coal and fine fluxes, are placed on the sintering machine by a short, inclined swing belt feeder. Placement is controlled in such manner that a small pile of pellets behind a strike-off plate will crowd under without crushing or spalling as the machine pallets advance.

Bed depth is regulated so that down-draft heat wave and reaction waves of the calcining and carbonizing zones will reach the grate bars without burning off excess fixed carbon in the top of the bed, and without reoxidization of the upper layer of pellets, as discharge occurs.

The first treatment zone is a drying stage. It is well known to operators of sintering and pelletizing plants (Figure 3) that proper preparation of the burden, and its proper structural bedding, may require higher moistures than would be desirable for processing. Gases from the hot zones are drawn down through the bed. In this instance down drafting has been more satisfactory than the up drafting often used in other techniques.

The second zone, which does not require any special separation from the preceding and succeeding zones, is the ignition stage. A simple torch or burner is all that is required. Proper fuel content and maximum bed permeability result in practically instantaneous full-depth ignition, and the pellets pass to the calcining and carbonizing zone which is covered by a continuation of the same hood which covers the other two zones so that normal air, or dilutions of the oxygen content, may be provided as required.

In about ten min the desired reactions have been completed and the pellets, each a complete metallurgical charge for fast smelting, are in approximately the same state as the descending blast furnace charge would be in about four or five hr after entering the furnace. The ore and fluxes are firmly bonded in the red hot pellets by a char-coke formed during the third stage, and with the intimate mix of ore, flux and fuel particles, a fast and efficient smelting action is to be expected.

The furnace charge has been beneficiated. Bins, feeders, conveyors, a ball mill, a slurry pump, a filter, a shredder, conveyor or belt scale, a pelletizer and a sintering machine, all of which are in common use and understood by metal producers, have functioned in co-ordination.

Graphs which have appeared in various literature and reports show the isotherms for reduction of iron oxides at various temperatures. A temperature-time-per cent reduction graph (Figure 4) is, up to the curve of 2000 F, essentially composed of known reduction isotherms for iron oxide taken from various solid phase data. The curve for 3000 F has been plotted through extrapolation and indicated curvatures from the other curves to represent dropping the high temperature pellets into the electric arc furnace. It should not be

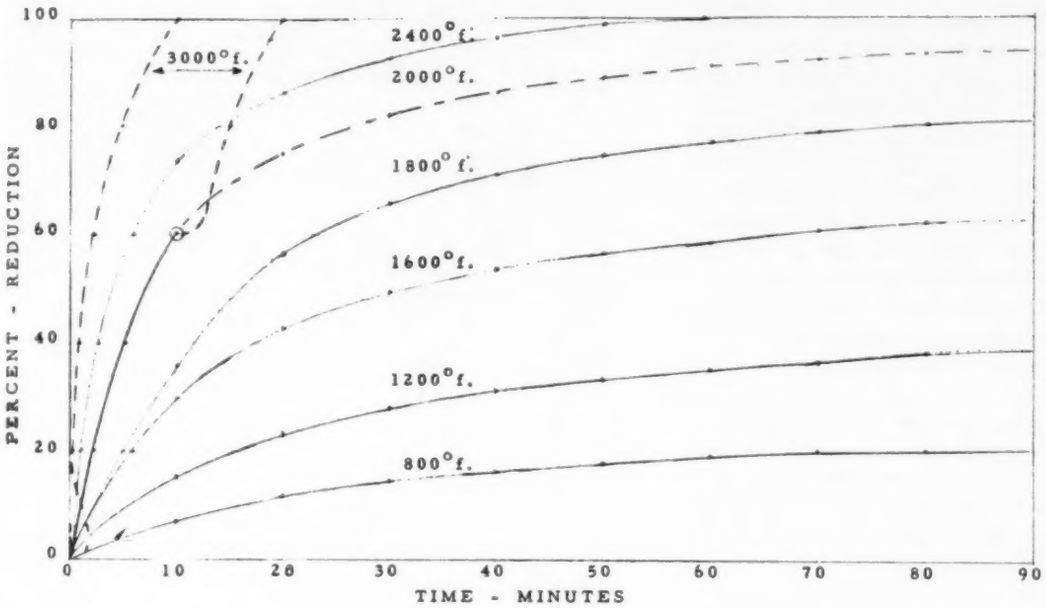


Figure 4 — The process time, temperature, per cent reduction curve is shown in relation to known isotherms.

read as true technology, but rather as a means of illustrating the text.

The solid line which proceeds to the ten min, 60 per cent reduction co-ordinate is that of the pellets on the sintering machine. At this co-ordinate the line bends off into an uneconomical flat curve, so, although a much higher reduction can be achieved in this stage, it is at the expense of considerable time. Laboratory tests on pellets have shown oxygen losses corresponding to the isotherm, so it is assumed the process follows the graph. The curve is continued as a dot-dash line for illustrative purposes only.

This co-ordinate is where the hot pellets are transferred to the final smelting furnace. Again for illustrative purposes the section of the high temperature isotherm, the dash-dash curve, has been moved to meet the pellet curve at the co-ordinate point. The final reduction is extremely fast as the pellet becomes hot metal. Curves of lower-temperature isotherms are also presented for illustration only.

Transfer of the hot pellets (Figure 5) to the furnace is accomplished through use of an insulated skip car. Very little reoxidation occurs during the transfer, nor is there any significant heat loss. The skip car sits on a recording scale. When the set weight is reached, the discharge surge hopper closes, the car rises to the furnace feed chute, dumps the pellets and returns, the surge hopper is reopened as the car comes to rest on the scale. The entire operation is automatic.

The smelting furnace is a 3-electrode unit. A small-capacity combination surge and choke feed hopper feeds hot pellets into the center of the electrode triangle, see Figure 6. Because there are no irregular shaped pieces of ore, coke or flux to impede material flows, this simple feed system is very effective. Due to the highly reactive char-coke which was made in the first stage, as an inherent component of the charge, and the naturally high resistance of the lightly oxidized pellet skins, gas flow is never choked. High voltages are used and excellent control of electrode position just above the molten pool is maintained.

The furnace is a closed-top type and operation is maintained with a smothered arc. Furnace gases rise through the bed of hot descending pellets and high CO_2 gases are exited through short flare stacks. Although gases high in CO are produced in the furnace, they pick up oxygen while rising through the cover of hot pellets and emerge at a high CO_2 ratio.

Figure 5 — Hot pellets are transferred from the sintering machine to the furnace in an insulated skip car.

Figure 6 — The pellets are deposited in the furnace by means of a feed hopper which discharges in the center of the electrode triangle.

From the initial surge bin feeder, through the sintering machine and the furnace choke feed hopper, synchronization with a short stock column descent to the melting zone maintains a continuous operation.

Operational expediency and metallurgical control have dictated that the furnace pool be tapped on definite time cycles in the pilot plant. Slag and metal tap holes are provided but, again for operational conveniences, taps are usually made from the metal tap only, see Figure 7. Molten slag and iron run into lined pots, the slag is decanted and the iron is cast into 100-lb standard pig molds mounted on a cascade tilting rack. Arrangements permit use of a fore hearth or mixer if desired.

Destructive distillation of high-volatile, low-swelling-index, coal during formation of char-coke bonded pellets creates gases visible as a thick yellowish-gray smoke containing recoverable Btu. Although full production indicates consideration of a waste heat boiler or other recovery equipment, it has been found expedient during pilot runs to incinerate the gases in a simple refractory-lined chamber which results in a clear discharge stack, removing any possibility of air pollution or other public nuisance.

The final phase, production of hot metal from highly beneficiated pellets, like the preceding stages, has used only the familiar tools of the smelter, a charging bucket or skip car, an electric furnace, slag and iron ladles and pig molds.

In one comparative test, two companion periods of operation were conducted to obtain correlated data of the well accepted Tysland-Hole smelting method and this newly developed method. Within very close limits each campaign consumed the same time and the same amount of electrical energy. Because of differences in power requirements, much more pig iron was produced for the same total electrical energy than by the Tysland-Hole smelting method.

Iron ore concentrate used for each run was from the same source. For the Tysland-Hole operation, standard

Figure 7 — Slag and iron are tapped together and the slag is removed by decanting.

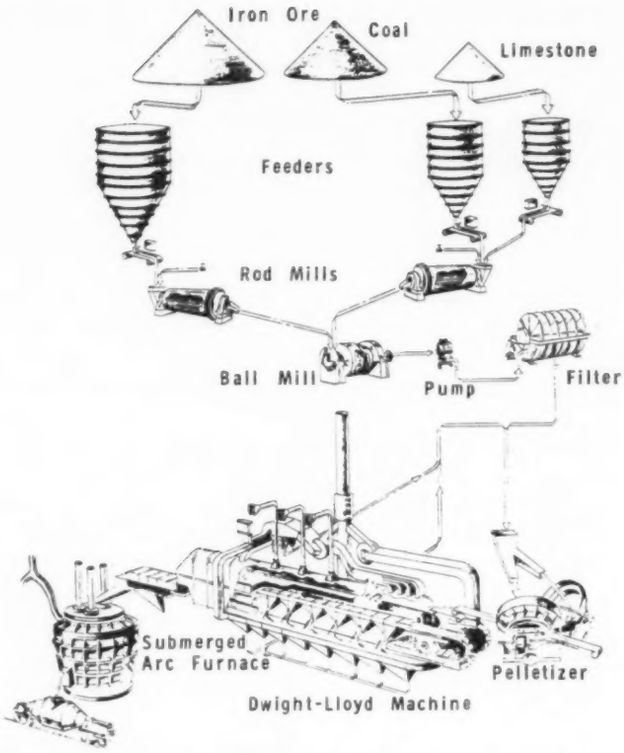


Figure 8 — Screened raw materials are crushed in rod mills prior to balling.

self-fluxing sinter was produced to give a highly beneficiated furnace charge, and a good grade of metallurgical coke was used.

For the D-LM operation the concentrate, flotation steam-grade coal and fine limestone were pelletized as received, without use of the grinding circuit previously described.

It has not been the primary purpose of this article to discuss the financial or technological aspects of the D-LM process or plants. As papers presented elsewhere have discussed these factors. However, a few of the developed facts should be mentioned.

Figure 8 indicates a plant where raw materials have been received as screened products. Storage, such as an ore yard, is represented by bins and feeders. Primary crushing is indicated by rod mills with the feed prepared in a ball mill.

Excluding storage facilities and primary crushing, a single-unit plant with a daily capacity of about 550 tons of iron will require about 60,000 sq ft ground space, and will cost about $6,000,000 to $7,000,000.

Table I represents, when related to varied costs in scattered locations, a production cost range of $35 to $45 per ton of hot metal or pig. The cost variation is

TABLE I
Requirement per Net Ton of Pig Iron*

Ore fines, net tons (dry)	1.598
Noncoking quality steam coal, net tons (dry)	0.836
Limestone, net tons (dry)	0.424
Electrodes, lb	10.00
Electrical energy	
Furnace, kwhr	800 to 900
Plant, kwhr	62
Labor, man-hr	1.1
Maintenance	$1.56

* Based on 500 net tons per day of foundry grade pig iron, 168,000 net tons per year: Capital cost $6,000,000 to $7,000,000.

dependent on plant location and local costs of raw materials.

The aspects of producing metal from ore by this ironmaking process are:

1. It is successful.
2. It does not require special or intricate equipment.
3. Equipment used lends itself to intermittent operations when required.
4. Raw material requirements are much more flexible than for the blast furnace; that is, iron ore fines or concentrates which normally require agglomeration may be used, and low quality coal fines are perfectly acceptable.
5. An economically efficient operation can be carried on with product tonnages in terms of hundreds or thousands of tons per day.
6. Capital requirements are approximately one third of the cost of the conventional blast furnace with its attendant accessories, such as the coke plant, etc.

Discussion

PRESENTED BY

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Dr. J. C. Agarwal: Iron and steel producers are in the business to make money, and are always looking for a new process, a cheaper one or a better one, which will produce iron at a lower cost. A host of new processes have been developed, giving a great deal of choice.

To understand the proper significance of the development which the authors explained it must be related to the process which is the old stand-by competitor. To make things easier for comparison purposes, let us look at the energy requirement of this process as compared to the blast furnace process.

This process is in essence a partial reduction process, which reduces the iron ore to 67 per cent and then smelts it in an electric furnace. To understand the energy requirements of this process, the thermodynamics must be examined.

For 60 to 70 per cent reduction, the equilibrium constants of CO and H_2 over FE_3O_4 and FeO dictates the minimum amount of moles of reducing gas necessary to do the reduction.

It is interesting to know that when the radiation losses are taken into account (100 per cent equilibrium conversion of carbon monixide is not approached) the heat generated to give the required amount of reducing gases necessary to do the reduction to 60 to 70 per cent is in balance with the heat required to do the job.

The problem arises in going beyond about 60 per cent reduction. Then a lot more reducing gases and more heat is needed, but more heat is produced than that can be used. Accordingly in any process, either this heat has to be wasted or some method has to be devised to utilize this additional heat. Any process to compete with the blast furnace will have to do the same. How does the blast furnace go about doing it? It does it: (1) by gasifying endothermically a small amount of carbon to soak up this heat and to generate additional amounts of carbon monoxide; (2) by melting the reduced product.

In this prereduction process, there is an inherent waste of energy. The modern blast furnace, together with the sinter plant and its auxiliary, uses about 14,000,000 Btu in the form of carbon consumed and about 150 kw of power per net ton of hot metal. While this process 21,000,000 Btu in the form of carbon and heat plus about 900 kw of energy per net ton of hot metal are used.

It will take some very, very special set of circumstances to make any process as economical as one in which you only use one sixth the amount of kw energy and approximately 50 to 60 per cent of the thermal energy.

The United States Steel Corp. has looked at most direct reduction and other process improvement developments in iron technology, and has yet to find a process which, on the investment basis, competes with the blast furnace.

The turnkey job, as the authors have described, would cost approximately as stated, but by the time everything necessary to make that plant produce hot metal was put in the cost of plant would be approximately the same as the plant furnace process of equivalent capacity.

Harold E. Rowen: Dr. Agarwal makes a point of comparing this process with the blast furnace on a heat basis rather than on an economic basis; however, it is of interest to review the aspects. Fourteen million Btu of the blast furnace and sintering plant requirements as coke would represent approximately 1150 lb, which may be an extremely low assessment in view of the fact that the average blast furnace in the U. S. is reported to require 1500 lb per ton of iron for smelting the burden, and approximately 150 lb for sintering fuel when using a 50 per cent sinter burden. These prevailing coke requirements, and a coke cost of $15 per ton, would indicate a fuel bill of about $12 per ton of metal as against the presented coal cost for this prereduction process of $6 to $7 per ton of metal. Perhaps it might be more equable to compare the lb of coal required for each process, without regard to by-product recoveries. It is interesting to notice that the blast furnace has a greater coal requirement.

The inherent efficiencies of counter-current exchanges and thermal reactions of the blast furnace are fully

recognized and acknowledged. However, this efficiency is purchased at the cost of special processed raw materials such as screened ore, sinter or pellets and sized metallurgical grade coke.

In any evaluation the specialized set of circumstances of having this process compete with the blast furnace are related to pure economics. There are many factors other than straight thermal balances which must enter the accounting. Perhaps the facility of operating economically at reduced tonnages has been given too little attention in this respect, or the gaining of operational benefits from unitized systems of production require careful examination in the over-all assessment. This certainly has been a prevailing factor of iron production costs at blast furnace works during the past several years.

W. H. Collison: Unlike many processes for the production of iron by methods other than the blast furnace, this process aims at producing a pig iron of similar quality and properties to that produced by the blast furnace.

How does the carbon content of this process compare with the blast furnace iron? How do silicon, manganese, phosphorus and sulphur behave in this process?

The product of the sinter machine is described as "hot char-bound pellets." Is it inferred that the carbonization has produced the bonding, unlike self-fluxing sinter and pellets from ore concentrates? Is there any difficulty in controlling pellet quality and degree of reduction of iron? Are variations in these properties any problem in the electric furnace?

Is ore quality important? Calculating back from the ore usage in the operational requirements, the Fe content seems to be about 54.5 per cent.

A blast furnace man cannot refrain from noting that the coal consumption is the equivalent of a coke rate of about 1250 lb per ton of iron.

The stone rate is approximately 850 lb per ton. Slag volume is not given, but would be about 950 lb. Can the authors tell us something of the slag analysis and possible uses?

Harold E. Rowen: Generally, in the operation of pilot plant facilities, the burdens were designed for the production of foundry grades of iron and normal varieties of slag. However, burdens have been designed for, and have produced, basic pig iron and silvery pig when required. Conditions controlling the disposition of silicon, manganese, phosphorous, sulphur, etc., to the iron or slag are very similar to those obtained in a conventional submerged arc electric furnace, which in turn are somewhat similar to those of the blast furnace.

The furnace burden, the sintering machine product, is comprised of char-bonded pellets which are individual little spheres each containing partially reduced ore, calcined lime and carbon in the form of a coke-like char which bonds ingredients into a tough pellet. Control of this pellet composition is attained by adjustments of the table and corrective additive feeders. Further control of the carbon content of the carbonized pellets is accomplished by alterations of the sintering machine draft and retention time.

Minor fluctuations of the residual carbon content of the pellets do not affect the operation of the electric furnace. However, drastic changes will affect the electrical characteristics of the furnace burden which in turn will affect the electrode positioning and operation of the furnace. Up to the present time experience has shown that the most important criteria for assessing ore quality are the economics governing the increased costs always inherent with large slag volumes which normally result from lower grade ores.

L. G. Cannon: This article is of considerable interest to the electric utilities, for the idea of making iron by such means as this process might be said to be natural because it involves the use of electricity rather than some other form of energy. The interest centers in the fact that the process is a "good load." In the first place, a plant using the process will, for its own economy operate the equipment on a high load factor basis, i.e., practically continuously. A second consideration is that the motor drives and the electric furnace can be expected to develop a reasonably good power factor. Finally, the operations of the electric furnace for ironmaking will not have the highly fluctuating load characteristics that have been experienced with scrap iron melting furnaces.

The first two considerations, high load factor and reasonably good power factor, will have the effect of enabling the electric utilities to offer their best rates. It is not possible to generalize about the level of electric service rates for a load of this type, but these two factors, together with the size of the load, are bound to produce the lowest possible rate that any utility can offer. The last point, namely, the smoother character of the furnace operations, should make it possible for many utilities to serve the load without the necessity of installing special equipment to control voltage fluctuations. Of course, the load may require service to be rendered from high voltage lines but utilities of the metropolitan type can be expected to have such lines in many parts of their systems and other utilities may very well find it feasible to project such lines to serve the load.

The interest of the electric utilities will be such that they will be glad to participate in studies of prospective installations in their respective service areas.

Ben Lyons: It was necessary to install about one mile of 33,000-volt line to serve the original pilot plant, and it was done at no cost to the customer.

According to some persons, apparently nothing can compete with the blast furnace for making iron, which surely depends on the point of view and commitments made.

The authors are to be complimented for saying that this process will work and will be competitive with other ironmaking processes. It is felt that this process will work and will be competitive, and that sooner or later the intelligent foundry man and people who need incremental amounts of iron will resort to this or other processes of this type.

Harold E. Rowen: The splendid spirit of co-operation received from the electric utilities has been most gratifying. Because the cost of electric energy is important to the economics of this process, it has been pleasing to see the favorable reception they have given the development of it.

J. E. Allen: The 0.9 ton of coal is equivalent to 1285 lb of coke. The modern blast furnace is producing iron using 1150 to 1500 lb of coke for the entire smelting process. The flux rate of 0.4 ton compares with the

modern blast furnace of 500 to 800 lb.

Certainly one item which is most outstanding is the flexibility this process presents for intermittent operations. What time is required to reach full temperature and what iron temperature is produced during full operations?

A feature which is impressive is the ability to "dial analysis" by control of the electrical input. Would the authors explain this feature?

Harold E. Rowen: The feature of control "dialing analysis" which was referred to is found with many conventional submerged-arc electric furnace smelting operations and is accomplished by sustenance of the electrode arcs within the furnace crucible at various levels through control of electrical conditions and burden composition. This allows variations of bath temperatures and consequent control of product compositions. In the pilot plant the iron temperatures normally range between 2600 and 2800 F.

Starting with a cold furnace approximately 30 hr may be required before the furnace crucible stabilizes at its operating temperature, although a normal iron tap is usually made approximately 12 hr following the initial start of the furnace.

Harry W. McQuaid: When this complete process is reviewed it seems to be quite simple and involves nothing unusual or which cannot be overcome by a combination of broad designing and operating experience with ore and coal handling, in a modern steel plant sintering operation. The building up of operating data on the processing (reduction) of many ores and coal combinations during the past years has established a foundation which portends the wide success and acceptance of the process. The many difficult problems incidental to its successful operation are apparently soon forgotten.

Developments in steelmaking, and especially the change in melting practice which requires a much higher percentage of hot metal in the charge, have greatly increased the pressure for more production from the blast furnace. The high investment required by the blast furnace, its dependence on special coke and its high minimum size limitations has caused a strong pressure for the development of a lower cost, and more flexible production unit. The result has been a great number of new processes and suggestions for equipment and methods to replace the blast furnace. The process described by the authors seems to be the most practical and should appeal to every important user of pig iron and hot metal.

The design is especially of interest to the pig iron buyer but with some modification should find a good field of application with the smaller steel production plant whose economic stability now depends on the highly variable price of steel scrap. This is especially true in countries such as Japan, etc., where economical steel production is difficult to obtain because of the lack of scrap and other raw materials.

It would seem that hot semi-reduced iron ore from the sinter machine could make an ideal charge for a submerged-arc furnace, or an inclined hearth furnace, where the melting and reduction would be completed under a fuel type burner of the right design, having enough oxygen enrichment to control the rate. The principal hurdle in the path of the submerged-arc melting furnace now is the relatively high cost of power and charge preparation should go far to remove this. The proper combination of the sintering process with an external method for removing sulphur, silicon, phosphorus and carbon would certainly make it attractive to most electric furnace or open hearth steel plants.

Harold E. Rowen: Although the conventional submerged-arc electric furnace has been given primary attention for use as a vessel for smelting the carbonized pellets, other types of furnaces have been investigated experimentally and will be further investigated in the future should the occasion demand. ▲

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DEALING WITH

ONE of the major unsolved problems of the steel industry is the effective control of open hearth furnace fumes, a problem which has been aggravated in recent years by the increasing use of oxygen lancing. An effective gas cleaning plant has been developed, but its use requires large capital expenditure and appreciable operating and maintenance costs. These costs are a direct charge on the steel produced, and are only slightly offset by using the captured fume as raw material in a sinter plant and in increased heat economy.

A 200-ton open hearth furnace produces about 25,000 scfm of waste gases, i.e., 100,000 cfm at 1400 F, the approximate temperature of the gases as they enter the waste heat boiler. Fume concentrations in these gases are usually low; less than 0.173 grain per cu ft during melting, the most time consuming operation, and only about 0.043 grain per cu ft during fettling. Fume concentrations are much higher during refining (about 1.3 to 1.73 grains per cu ft) and during oxygen lancing and lime boiling they average about 2.6 grains per cu ft. These data apply generally to both basic and acid melting practice. During most of the cycle of steelmaking operations, the chemical composition of the fumes leaving the regenerator is about 50 per cent iron oxide (both Fe_2O_3 and Fe_3O_4) with calcium oxide, silica and the oxides of sulphur constituting much of the remaining material. During oxygen addition to the melt the proportion of iron oxides (mainly Fe_3O_4) increases to over 80 per cent while during working the melt, boiling and ore addition it is also above 60 per cent.

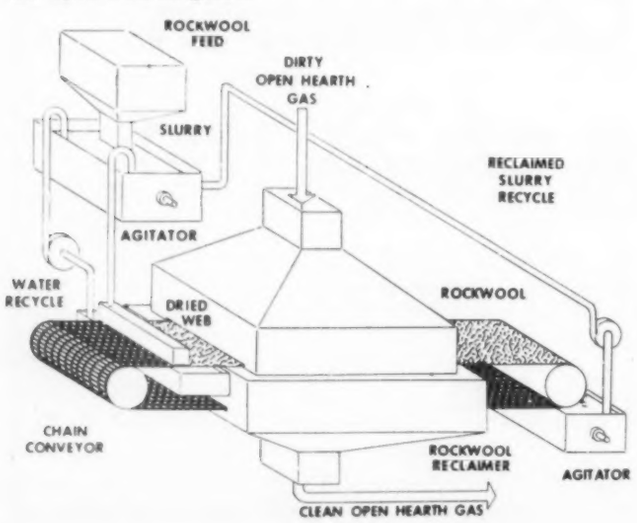
The sizes of the fume particles vary between about 0.01 to about 5 microns, but single particles of about 0.1 micron and agglomerates of about one micron form the bulk of the fume. Whytlaw-Grey and Patterson found that agglomerates of these sizes have a falling speed similar to a particle of the same size but only one tenth of the density of the material in bulk. The small particles, however, from electron micrographs, appear to be solid.

On the basis of the mechanics of particle motion it can be shown that certain mechanisms, which are listed here, can be used to remove the fine fume particles from the furnace waste gases.

1. Impingement and interception of the fume particles by fine fibers, other small particles and/or droplets, these being all of the same order of size as the fume particles.
2. Diffusion to a surface across a concentration gradient.
3. Thermal precipitation through a thermal gradient.
4. Electrostatic precipitation.
5. Magnetic separation of the particles at temperatures below the Curie point of the material.
6. Agglomeration of the fumes as a precursor to mechanical separation.

As these methods have been found the most successful in practice, their application will be discussed in some detail.

Figure 1 — A continuous bed of slag wool was exposed to the open hearth gases.



COLLECTION BY IMPINGEMENT, INTERCEPTION AND DIFFUSION

It was suggested by R. T. Pring after some pilot plant experiments in 1954 that bag filters would be commercially feasible on open hearth furnaces. In these experiments the gases were cooled to 284 F and passed through orlon filter bags. The resistance of the plant, including the bags was 1.1 to 1.6-in. water gage, a low value which could be easily supplied by a natural draft chimney. The filtering efficiency, virtually 100 per cent, was even better than that obtained with electrostatic precipitators.

A large bag filter plant has been installed on a 300-ton tilting open hearth furnace (the Ajax) at the Appleby-Frodingham Steel Works in England. Here 15 compartments with 14 bags in each, 210 bags altogether, are used, giving a filtering area of 5200 sq ft. The waste gases, which have an initial dust load of 13.0 grains per cu ft, are first cooled in a waste heat boiler, then further cooled with diluent air to 275 F, so that 730,000 cfhr are cleaned to a final dust concentration of 0.0048 grain per cu ft. Pressure drop across the bags was 3-in. water gage. The original bags failed almost at once, and orlon bags lasted for only a few weeks with a slightly different operating technique. However, the temperature of the plant has now been raised above the dewpoint of the gases to 316 F and much longer filter life has been achieved. Cyclones which were initially installed on this plant have been removed, as their low efficiency with the fine fume (nine per cent) cannot justify their operating cost, for their pressure drop is high. The capital cost of a bag filter plant is lower than that of an electrostatic precipitator, the space requirements are much the same, but the maintenance costs,

FUMES FROM THE OPEN HEARTH

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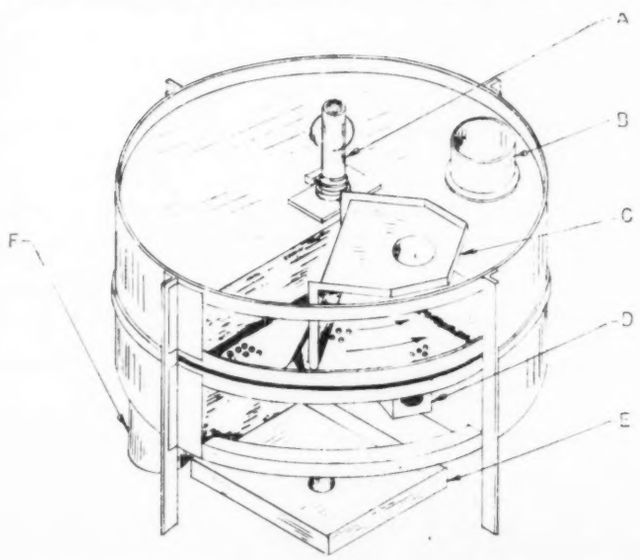
. . . . increased oxygen usage in the open hearth furnace has greatly increased dust concentration in the waste gases . . . . a survey of present processes and possible future developments indicates that gas cleaning efficiency will keep pace with fume conditions . . . .

particularly with the bag replacement, appear to be much greater. The dust load on waste heat boilers is not reduced, and considerable operating difficulties have been experienced.

Very ambitious experiments have been carried out by Silverman and his co-workers at the Harvard School of Public Health, where attempts have been made to filter the waste gases hot, before the waste heat boiler, using slag wool as a filter medium. Laboratory studies have shown that a 1-in. layer of slag wool (packing density five lb per cu ft) will remove over 90 per cent of the iron oxide fumes from a gas stream at 1022 F with a filtering velocity of 1.67 ft per sec. The resistance to flow was about 2-in. water gage initially, and increased to 4 in. when the bed was considered exhausted, having collected about five per cent of its own weight in fumes.

On a pilot plant scale, the slag wool was fed to a moving chain belt conveyor in the form of a slurry (Figure 1). The hot gases dried the slurry and formed the filter bed. Owing to mechanical sealing difficulties the average collection efficiency was only 50 per cent. A modified unit (Figure 2) was then tried, in which the slag wool was loaded on to a circular conveyor with quadrant sections. The sections were in turn loaded with slurry, dewatered, and after acting as a cleaner, removed. Average resistance of the unit was 4.1-in. water gage, and the gas velocities ranged from 1.0 to 1.7 ft per sec. The efficiency of this unit was, unfortunately, even lower, averaging about 44 per cent. A screw agglomerator, placed in series with the filter improved the average efficiency to 60 per cent, with a resistance of 6-in. water gage, and flow rates of 1 ft per sec through the bed. On some occasions the efficiency was as high as 90 per cent, showing that with improved mechanical operation and a reduction of leaks, this efficiency could probably be maintained. At the United Austrian Iron and Steel Works at Linz, Austria, a slag wool filter was 75 per cent efficient in dealing with L-D process fumes. The Austrian workers, Vacek and Schertler, also obtained efficiencies of 64 per cent when treating L-D fumes by passing them through a coke bed filter.

Figure 2 — The slag wool filter illustrated consists of: the disk driving shaft (A), the hot dirty gas entry (B), the slag wool slurry charge point (C), the dewatering suction box (D), the draining pan (E) and the clean gas exit (F).



Vajda, in 1952, used a pebble bed filter on a pilot scale. Granules of coke breeze or dolomite, varying between $\frac{1}{8}$ and $\frac{1}{2}$ in., in layers four in. thick, were used to filter open hearth fumes. Efficiencies as high as 78 per cent were obtained, with a filter bed resistance between 4.6 and 6.3-in. water gage. No flow rates or gas temperatures were reported. Vajda mentions that in spite of the relatively high efficiencies occasional puffs of fume were produced. It was also found that the dolomite pebbles interacted with the SO_2 in the waste gases, and deteriorated. He did not consider that this reaction could be used as a method of removal of SO_2 as well as the fume.

Experiments at the University of Sheffield measured the fume collecting efficiency of beds of different depths

of high temperature insulating brick, crushed and graded between 7 mesh and $\frac{5}{16}$ in. The pilot plant (Figures 3 and 4) was operated at temperatures as high as 1112 F and with small modifications, such as lining the high temperature side with insulating brick, could be operated as high as 2192 F. The efficiency of a 9-in. thick filter bed was, in some cases, better than 95 per cent, with a pressure drop of 3-in. water gage and a velocity through the bed of 1.6 fps. The average filter efficiency was 80 per cent, with an average gas velocity of 1.2 fps, while the pressure drop varied between 2 and 4-in. water gage during four melting cycles and 48-hr operation, when the bed was used regeneratively.

In a venturi scrubber high pressure water sprays are introduced at the throat of a venturi placed in the exit gas duct, followed by a centrifugal spray separator. At the throat the dirty gas is brought into intimate contact with the very finely dispersed water droplets, and there is also the possibility of an electrostatic effect due to the charging of the water droplets by the atomization process, although work at the University of Illinois Engineering Experiment Center under F. H. Johnstone have shown this to be only a minor effect.

The three variables in operating a venturi scrubber are the velocity of the gas in the throat, the liquid gas ratio and the liquid distribution in the throat. The high pressure drop is largely due to the energy required to atomize and accelerate the liquid. In a German installation the throat velocity is 210 to 270 fps, the pressure drop is 12 to 20-in. water gage, and power consumption is 0.06 to 0.1 kwhr per 1000 cu ft of gas, while water consumption is 37 to 50 gal per 1000 cu ft. In a venturi scrubber where there are two tubes, 12 and 19 in. at the throat, respectively, the plant handles 70,000 to 80,000 cfm. This plant is 95 to 99 per cent efficient, uses only 3.3 gal per 1000 cu ft, but has a pressure drop of about 30-in. water gage. It has been suggested that the addition of wetting agents to the cleaning liquid may assist in wetting the fine particles and reduce the degree of atomization required.

A new design has recently been introduced in which several smaller venturi tubes are operated in parallel. This is a versatile design, more flexible than the conventional single throat, and it has a much lower pressure drop without loss of efficiency (Figure 5). Unfortunately a venturi scrubber will only deal with comparatively cool gases (about 709 F) after a waste heat boiler. It also cools the gases further without the recovery of high grade heat, and emits the gases as a cold plume without buoyancy to assist dispersion.

TABLE I
Cleaning Mechanisms and Their Practical Application

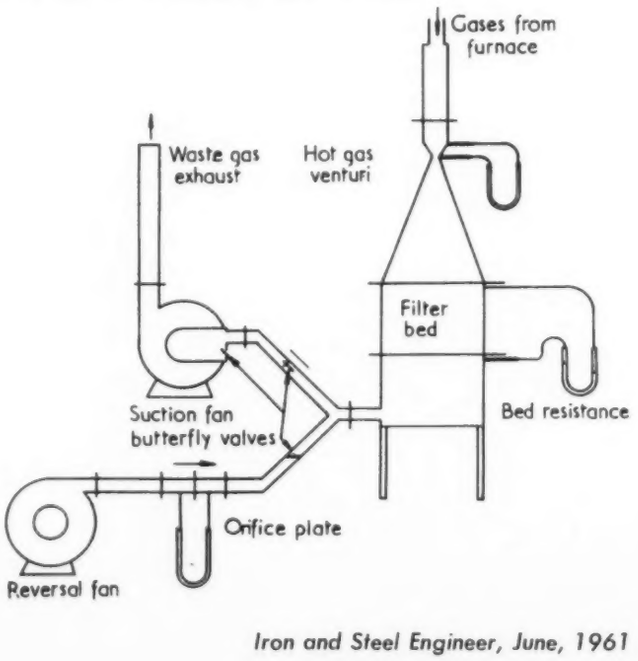
Mechanism	Application	Efficiency, per cent	Comment
Inertial separators	Multicyclone	43	Could only be used as a preliminary separator[1]*
	Dry inertial separator with fan	23	
Separation by impingement, interception and diffusion	Conventional Baghouse	Almost 100	Temperature of filtration governed by filter material[2] Filter cloth also has short life if gases below dewpoint[3]
	Slag wool	40 to 90	Low efficiency due to mechanical problems in continuous pilot plant
	Pebble bed (dolomite)	78	Dolomite reacts with SO_2 in waste gases and deteriorates[1] [5]
	Coke breeze	64	
	Crushed brick packed bed	Up to 95	Mechanism combined with thermal precipitation[6]
	Venturi scrubber	95 to 99	High running costs, suitable for intermittent use[7]
	Wet inertial separator with fan	45	(1)
Thermal precipitation	Crushed brick packed bed	Up to 95	Combined mechanism[6]
Electrostatic precipitator	...	Over 99	Widely applied
	Electrostatically charged filter cloths	Not tried	Resins used to retain charge would not withstand high temperature
Agglomeration	Sonic	90	Doubles efficiency of conventional inertial separator but not economic[1]
	Mechanical		Improves efficiency by an additional 33 per cent of untrapped material[4]
Magnetic separation	No details available	85	Possible supplementary collector[5]

* Numbers in parentheses refer to Bibliography at end of article.

ELECTROSTATIC PRECIPITATION

In the U. S., particularly, electrostatic precipitation has been the most widely adopted method for cleaning open hearth waste gases. Published reports from both the Fairless and Torrance works of U. S. Steel Corp.

Figure 3 — Beds of crushed insulating brick were evaluated as filter media using the system shown.



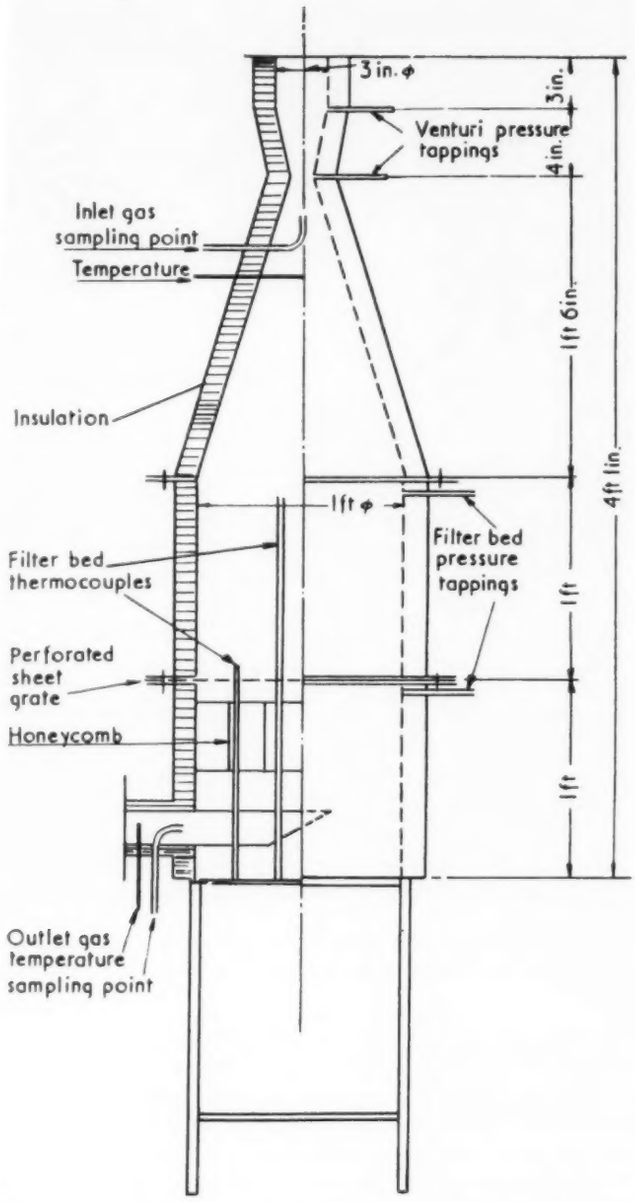


Figure 4 — Filter operating temperature was 1112 F, but it could be raised to 2192 F by slight modification.

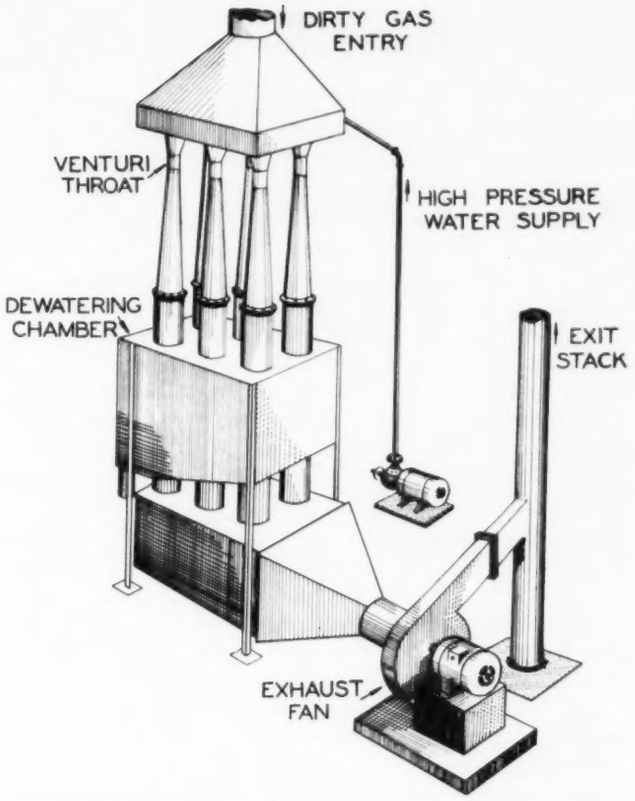


Figure 5 — Operation of several venturi tubes in parallel reduces the pressure drop without reducing the efficiency of the scrubber.

give efficiencies averaging 98 per cent. At Fairless the constructional details for a plate type precipitator are: the plates are 18 ft wide, 17½ ft high and ¼ in. thick, and are spaced at 10-in. intervals, with 18 plates across the precipitator chamber, forming 17 lanes through which the gas passes. The discharge electrodes are $^{3}/_{16}$-in. sq steel wires, 19 ft long, suspended at the centers of the gas lanes formed by the collector electrodes, and are negatively charged to 65 kv. There are ten wires per lane per field, a total of 170 wires per field, and a total of 1020 wires in the chamber comprising one precipitator. The precipitated dust is periodically removed by an air-vibrator rapping system.

The chambers are attached in pairs to 330-ton open hearth furnaces, and were designed to handle 75,000 cfm each at 572 F, with a normal dust load of 0.78 grain per cu ft (based on duct temperatures) and to clean this gas with an efficiency of 98 per cent. During oxygen lancing, when the dust load is 2.6 grains per cu ft, the exit concentration is 0.048 grain per cu ft, and even during blowing the checkers, when the dust load is twice this, the exit concentration does not exceed 0.10 grain per cu ft. During maintenance, at low dust loads one of the precipitators alone can handle the dust load. Dust collection from the precipitator hoppers is by a suction line system, leading to a primary and secondary cyclone followed by a venturi scrubber, all connected to a common hopper. Here the dust is thoroughly wetted to simplify disposal. However, during lime boiling a faint brown plume still exists, and it is hoped to reduce this by improvements to the power regulation and controlled corona electrodes, with approximately twice the efficiency at high dust loadings.

The enormous size of the precipitator installation can be deduced from the above description. Also the gases when they come from the furnace must first be cooled in a waste heat boiler to below 572 F, and sometimes preconditioned by the addition of water vapor. Although operating costs are low, the capital costs of the combination of waste heat boiler and electrostatic precipitator is very high, being of the same order as the rest of the furnace installation. The disadvantages of the electrostatic precipitator can be summed up as follows: high initial capital cost, large space requirements and the necessity of using waste heat boilers (or other pre-coolers) under difficult operating conditions of very high dust burden.

AGGLOMERATION OF PARTICLES

Increased coagulation of fume particles to improve the efficiency of collection by interception, centrifugal forces or settling can be brought about by sonic energy, thermal diffusion, increased turbulence or electrostatic

charges. One other mechanism could be added: as some of the fume is magnetic, the fume could be exposed to a magnetic field.

A magnetic agglomerator, of which no details have been revealed, was tried by Austrian workers on the L-D fumes and proved to be 85 per cent efficient.

Vajda improved the performance of a wet type inertial separator with a fan from 45 to 90 per cent by using sonic agglomeration in conjunction with wetting the dust, although sonic agglomeration before a dry inertial separator with a fan improved the efficiency of this unit only marginally. Considering that a sonic agglomerator-cyclone unit with sound insulation costs more than an electrostatic precipitator to install, operating costs are higher and so are maintenance costs, it is unlikely that this type of cleaner will be installed, unless a breakthrough in sound generation equipment for this purpose is accomplished.

A screw agglomerator was tried by the Harvard workers in conjunction with the slag wool filter mentioned before. The device consists of a conveyer screw placed in a pipe with a tangential gas inlet and outlet. The screw could be rotated to induce turbulence by rotation counter to the gas flow, and also permitted an extended path and increased surface for thermal contact agglomeration. The efficiency of collection was increased from 44 to 60 per cent for the combined agglomerator, slag wool filter as compared to the filter alone.

MECHANICAL SEPARATORS WITHOUT PRE-AGGLOMERATION

Vajda also experimented with two types of inertial separators on the pilot plant scale. A multi-cyclone set with a pressure differential of 4-in. water gage had an efficiency of 43 per cent, while a dry inertial separator with fan was only 23 per cent efficient. These low efficiencies could easily have been predicted from a consideration of the centrifugal forces acting on the submicron sized particles.

FUTURE DEVELOPMENTS

Satisfactory methods of cleaning open hearth furnace gases must have an over-all efficiency of at least 98 per cent, and the only methods achieving this at present, which have been tried on a plant scale, are electrostatic precipitators, and in one case, a bag filter house. Recent developments in artificial, glass and quartz fibers, which are chemically inert at higher temperatures without loss in strength, will extend the use of filter bags. However, space requirements of both these methods are such that they can only be incorporated in new installations, rather than added to an existing plant. The capital costs of the electrostatic precipitators are very high, and although the new, fully automatic bag houses are somewhat cheaper, the final answer can only be given when a satisfactory bag "life" has been achieved. As neither method removes SO_2, it is important that the gases leave the stack at a sufficiently high temperature (about 392 F) for the plume to rise because of the buoyancy of the gases and disperse the SO_2 at a great height.

A venturi scrubber is very effective, and will also remove some of the SO_2 (nearly all, if ammonia or some other adsorbent material is added to the wash liquor),

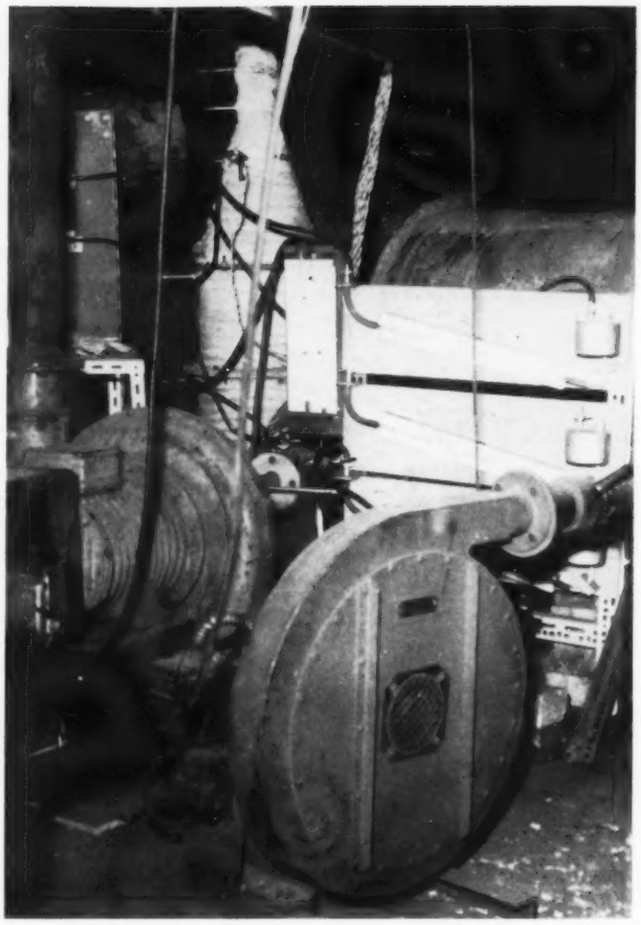


Figure 6 — Pilot plant installation of a granulated refractory filter bed indicated that high efficiency operation was possible.

but the power costs are high and the gases are discharged almost at ambient temperatures. The gases not removed settle in the immediate neighborhood without dispersing. Scrubbing techniques are particularly useful for processes where the fuming is for short periods.

More hope can be attached to the developments of an effective slag wool filter, and perhaps beds of granulated refractory material, see Figure 6. Both units have been shown to be capable of high efficiencies, although not as high as may be obtained with electrostatic precipitators or bag filters. In theory, slag wool filters should be as effective as bag filters, i.e., better than 99 per cent efficiency, but mechanical plant difficulties associated with continuous operation have not yet been overcome. Beds of granular material are quite efficient, and offer the opportunity for heat recovery from the hot granules.

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The Engineering—Purchasing Relationship

by W. W. CRAWFORD Director of Purchases, United States Steel Corp., Pittsburgh, Pa.

. . . . purchasing agents of today in their efforts to produce a co-operative effort in the accomplishment of purchasing objectives have become "a different breed of cat."

THIS article discusses a number of things which are of interest in the steel industry. Maintenance and sales have many areas of common interest and responsibilities. However, since the day-to-day operations call for very close co-operation between engineering and purchasing, the discussion will be primarily concerned with the engineering—purchasing relationship. Purchasing and engineering are equally charged with a responsibility of conserving the funds of their employers, of contributing to the companies' profits.

It must be noted that the answer to the question: "Is it true that modern purchasing is taking the decision-making responsibilities away from engineering?" is No. However, the ramifications to that answer are many. It is felt that it is important to convey some of the considerations, in a concept of industrial purchasing, which reflect the degree of co-operative effort required by those who determine the manner in which their employers' money is spent.

In the first part of this discussion, the general function of purchasing in terms of policies, objectives, responsibility and authority are described. Secondly, several considerations which are vital to the joint responsibility of purchasing and engineering are discussed.

Purchasing has made significant strides in the past few decades toward attaining recognition as a profit generating function in the industrial enterprise. It was common belief for many years that purchasing was a service-spending function and should not be held accountable for net profit contributions. In other words, it was felt that as a consequence of purchasing, money flows from rather than to a company and purchases were merely an inescapable cost of doing business which no one could do much about. This concept of purchasing can be simply summarized: "get the goods." This was the old concept of purchasing, and purchasing people of that time were selected on the basis of their ability to carry out this minor assignment.

However, today they are *a different breed of cat.* Purchasing dollars saved not only contribute directly to profit, but they also enable a company to produce a better product or provide a better service and thus maintain a more competitive position in its industry. It is common knowledge that in the average manufacturing company approximately 50¢ of each sales dollar is spent for purchased goods and services, excluding direct labor. For such manufacturing companies, a four per cent savings in purchase cost could be as important, profitwise, as a 20 per cent sales volume increase. A profit, after all, is the difference between income and outgo. The size of the outgo is just as important in determining the ultimate profit as the amount of income.

Now, to provide purpose and direction in all efforts, there must be objectives. One of the basic objectives of good purchasing was defined many years ago: "To procure the right material, of the right quality, in the right quantity, at the right time, from the right source, at the right price." The word "right" should be interpreted to mean that which is to the best long-term interest of the company.

United States Steel Corp.'s purchasing objectives specify such things as, a high degree of job performance, promotion of friendly relations, co-operation with all departments, development of qualified personnel and the carrying out of corporation policies to the fullest possible extent.

A requirement for the attainment of these objectives is the need for a strong organization. An ample delegation of authority is fundamental to the activities of a well-run purchasing department. Purchasing work is built around the concept that purchasing agents and buyers will have not only the responsibility to do the job, but also will have authority commensurate with that responsibility. This minimizes clearances and makes for more efficient and effective job performance.

The relationship between engineering and purchasing should be examined further, for sound purchasing decisions cannot be made consistently without information and knowledge from all segments of an organization. Practical experience has demonstrated that pooled judgment, initiative, enterprise and the ideas of an entire organization operating as a coordinated, integrated team produce better results in terms of profit and progress. If purchasing and engineering do their jobs well, some of the eroding effects of inflation can be offset and their respective companies' competitive positions will be enhanced.

Expenditures for capital equipment are matters for serious consideration. No one has an unlimited source

of funds for capital improvements, and the impact of capital expenditures affect profit and loss statements for years to come. Certainly, no one needs an additional stimulant to exercise maximum co-operation toward attaining a common goal.

Capital purchases are unlike expenditures for raw materials where quality and quantity requirements and an evaluation of cost-price relationship can be readily determined prior to awarding orders. The known factors of any raw materials acquisition include an exact requirement, a precise analysis and a stable price over a period of time or for a specified quantity. Similarly, buying maintenance and repair supplies can be carefully analyzed and negotiated. While it is true that, on occasion, prices may fluctuate to the extent of making a previous commitment look bad, the impact on costs can be cushioned by averaging out the price through additional or curtailed purchases. This is merely to say that there are means by which alert purchasing can protect costs of process materials or repair and maintenance supplies.

However, such protection is not available in making a capital purchase. Once a piece of equipment has been specified and a covering order has been awarded, the die is cast, and the effect on future profits is established. While it is true that such orders can be modified or even canceled, at a cost, in most instances the course is established and must be followed. It is vital to the long-term profitability and to the long-term competitive position to pick the right course.

Now the important steps which engineers and buyers need to take in a real effort to preclude the possibility of a costly or wasteful mistake should be examined.

The specification is first and it is the responsibility of engineering. Whether the specification be functional or detailed, it must be remembered that prices obtained will be a direct reflection of the adequacy or skill with which it has been prepared. Good specifications permit factual pricing, poor ones lead to expensive contingency pricing. The ultimate cost of the equipment is so closely associated with the specification that a very careful analysis of the required function is an absolute necessity. Standard equipment should be used where it will perform the required function. Frills or "gold plate" add only to costs without necessarily benefiting performance. Without question, careful attention to clearly prepared specifications will result in lower costs.

Second in importance is the selection of bidders. The list must be satisfactory to all interests prior to initiating an inquiry. All interests include: purchasing, engineering, production, commercial and financial as a minimum. A potential supplier should never be invited to bid if there is not every intention of awarding him an order should he become the low acceptable bidder, for it costs money to prepare bids. The selection of the bidders must be based on such important considerations as proved performance, ability to complete the scope of work specified, financial responsibility and other factors. Lest it is felt that all contractors must meet all the tests of performance, financial, personnel and experience requirements of both purchasing and engineering, let it be added that new contractors should be brought into the picture. However, such action should be taken only after all aspects of the matter have been given full consideration; all the pros and cons weighed; and every available precaution taken to minimize the possibility of substandard performance.

A potential contractor must have complete knowledge of the safety requirements, policies with respect to insurance coverage and normal contract provisions.

The alternative to taking the calculated risk involved in contracting with a new supplier is having a set bidders list which invites price organization with resulting noncompetitive bidding. Suppliers who are traditionally high must be weeded out, if only to make room for newer, possibly more aggressive contractors with a recent history of acceptable performance.

Next is the inquiry itself and that is a purchasing function. No one should retain any old fashioned idea that purchasing insists on three bids. While competitive bidding by qualified suppliers is the best means yet devised to determine fair prices, no one can claim that it is always best. At times a negotiated price with a single selected source may be indicated. Another time it may be highly desirable to obtain a large number of bids.

Fourth is the evaluation of the bids. Such evaluation is preceded by affording the prospective bidders full and equal opportunity to become thoroughly familiar with the scope of work. It is felt that site visitation is essential to intelligent bidding. The evaluation is, first an unbiased engineering analysis, and in its final form, the combined thinking of all interests. This review should be in every sense a true evaluation of ultimate costs. Unique and novel ideas of a potential supplier should not be divulged to another. It is grossly unfair to "pick-the-brains" of the ingenious. A true evaluation will recognize such features. Any progressive purchasing department has available to it all of the source information so essential to an evaluation of a supplier's capabilities. Such information, in addition to the qualifications mentioned earlier, includes performance data on similar jobs, recent personnel changes, his record in the hiring halls, etc.

The purchase order itself is the final item. It is sufficient to say that it must reflect, in precise detail, the complete understanding of both buyer and seller. The order is a binding contract, in effect a partnership arrangement. It cannot be a "hunting license" to provide the buyer with an opportunity to see what extra work he can get for nothing or to provide the seller with a medium through which to issue extra charges. It is a mutual understanding, a mutual trust. Since purchasing is solely responsible for all the commercial phases of the purchase transaction, it must be purchasing's responsibility to see that any and all changes are acceptable and properly documented.

"Is it true that modern purchasing is taking the decision-making responsibilities away from engineering?" Of course not, purchasing is not qualified to do so and has no such desire. Today's purchasing is purchasing in depth, which recognizes the special talents of all other departments and solicits their expert knowledge to arrive at proper buying decisions. Purchasing is keenly aware of the inseparable nature of the engineering function with their own activity, and is cognizant of the cost savings potential in every purchase. Purchasing is justly proud of its association with engineering. ▲

Figure 1 — An aerial view of the buildings gives an indication of the general atmospheric conditions in the area.

Heating and Ventilating A Modern Steel Mill Building

by CHARLES H. SMITH, L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co., Inc., Linden, N. J.

. . . . proper distribution of temperature controlled air can, by insuring worker comfort, increase efficiency, in addition to protecting equipment and material from condensation and resulting moisture damage . . . .

IN THE steel industry, as in many other industries, a high percentage of the product cost is labor. To keep some measure of control over costs, continual improvement in output per worker is necessary particularly since it appears that wage rates will not decline but shall continue to rise in the foreseeable future. Much progress has been made in providing the worker with more productive processes and machinery.

In recent years, increasing attention has also been paid to worker hygiene, health and comfort. Most steel companies already have hygiene departments looking after the health of employees to the extent that steelmaking processes might affect them. Such attention is directed to the broader aspects of health, comfort and mental attitude as they influence worker efficiency.

One of the most important areas of study by company hygienists is that of heating and ventilation. It is becoming increasingly apparent that if employees are furnished with comfortable and healthy working conditions there will be less absenteeism and turnover and also increased production of workers on the job. Heating and ventilation are important factors in providing better, more healthy working conditions.

An excellent example of this up-to-date philosophy is the new cold strip mill recently completed by a Midwest steel producer. Not only is it modern in layout and equipment, but it was planned to provide working conditions substantially superior to the average in

the industry. An example is the system of 1000-watt mercury vapor lamps providing bright and clear visibility everywhere. A central change house was provided, with an underground tunnel to the work area. The change house is equipped with a filtered forced ventilating system and all mill offices are air conditioned. The attention to such matters paid by the consulting engineers was to provide working conditions which reduce costs through improved employee health and comfort, and morale and efficiency.

Probably the most significant contribution to good working conditions is the heating and ventilating system designed to bring in a complete change of air every hour, summer or winter, and to maintain uniform, comfortable temperatures throughout the entire mill, with neither hot nor cold spots, and without cold drafts in cold weather. Comfortable working temperatures are maintained throughout the winter, despite the mill's exposure to cold bitter winds.

This mill consists of eight main buildings running parallel and adjacent and mostly open to each other where they adjoin. They cover approximately 850,000 sq ft of area, about 20 acres. Over-all width of the area is 686 ft, and over-all length, 2472 ft. If all the buildings were put end-to-end, they would extend more than 1⅓ miles.

There were several major objectives in designing the heating and ventilating system. First was the furnishing of a continuous, positive supply of fresh air throughout the mill buildings, summer and winter. Second was automatically maintaining comfortable and uniform temperatures over the entire mill floor area, without the usual hot and cold spots or blasts that occur when heat distribution is not uniform. Other considerations were the design and location of the heating units to avoid cluttering the floor and column areas with ductwork and piping or causing crane interference. The use of a minimum number of heating units to simplify maintenance and inspection was also important. These objectives were met by the choice of overhead down-blow revolving-discharge unit heaters, installed in the roof truss area, complete with catwalks and service platforms, and by the use of both power and gravity roof ventilators.

Figure 1 shows an aerial view of the new cold strip mill, located within the circle. The structure housing the offices and the change house is not considered in this paper, since it has its own separate heating, ventilating and air conditioning system. The other eight buildings have no windows and most have no convection air openings in the sidewalls. Neither the heating and ventilation, nor the illumination systems need to be supplemented by windows or the usual number of wall openings; therefore, construction was simplified. All of the mill roofs are insulated, primarily to reduce condensation but also to reduce heat loss. Sidewalls are not insulated except for those of the roll shop building.

Figure 2 is a view down the No. 2 coil storage floor, giving an idea of the expanse covered by the heater units. From the truss area, at heights between 40 and 69 ft above the floor, the units cover building widths of 106 ft in the case of five buildings, and 126 ft in the other three. Units indicated by arrows, are located in a line down the center of each building. Note how heater mounting in the truss area avoids cluttering the floor

Figure 2 — Buildings of different widths (106 to 126 ft) are heated by a row of heaters located on the centerline of each building.

and column areas with ductwork and piping. The only ducts are short runs connecting the fresh air heater inlets with roof openings shown in the photo. Bottoms of the heater discharges are just above the bottom chord of the trusses, and provide adequate clearance for the cranes.

Figure 3 shows a unit installed above the 56-in. 4-stand tandem mill. Each unit's discharge velocity is adequate to deliver air to the working floor from 40 to 69 ft up. By the time the air reaches the floor it is well diffused, producing gentle moving currents rather than direct blasts as would have resulted had fixed discharge units been selected. The revolving discharge feature

Figure 3 — Air velocity is such that the air flow is well diffused at the floor level.

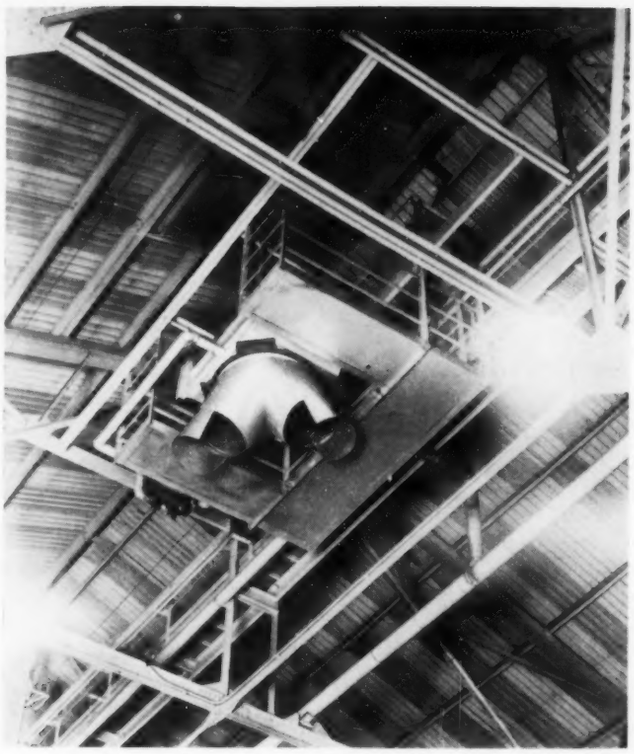


Figure 4 — The revolving discharge continually changes the flow pattern to directly cover a circular area of about 100 ft in diameter.

makes it possible to locate heaters and machinery and other solid objects without concern about the blocking of air flow. Since air discharge direction slowly but continually changes, there are no areas subjected to uncomfortable fixed streams of hot air from heaters, and no areas left "out in the cold." Absence of cold spots avoids condensation of moisture on material in storage.

To visualize the uniform distribution of the air, consider the revolving lawn sprinkler which covers a wide area uniformly. However, if the stream direction were fixed, it would damage the lawn by flooding certain areas and starving others.

Figure 4 shows a typical heater installation. One can see the access platform, the revolving discharge and its out-of-the-way location up in the trusses. Two different types of heaters were selected for the system; the fresh air supply, and the recirculating type. Fresh air units bring in outside air and heat it. Recirculating types recirculate inside air and heat it as necessary to take up heat loss from the building. Use of recirculating heaters, in addition to fresh air supply units, makes possible the return and redistribution of any hot air accumulating under the roof. This keeps the temperature differential between floor and roof to a minimum, thus reducing heat loss through the roof. Should the steam supply be reduced or impaired, all units can operate on recirculation and thus reduce the steam needs.

Figure 5 identifies the eight buildings which make up the cold strip mill. Building 1, at the extreme left, is the No. 1 coil storage building, where coils are received into the mill. Next across the top is building 2, the roll shop, with its roll blast leanto at the right. Next is building 3, the shipping area, and below this building 4, which includes a shear line and storage for coils awaiting processing. Building 5 contains the pickling line, the tandem mill, and the temper mill. Adjacent is No. 3 coil storage, which serves the annealing and normalizing departments located in buildings 7 and 8. As previously mentioned these buildings total 850,000 sq ft of floor area, see Table I. A more significant figure in regard to heating and ventilating is their total volume which is nearly 55,000,000 cu ft. This latter volume of air is changed every hour, winter and summer. The inside winter temperature is automatically maintained between 60 and 70 F.

The system design did not merely provide for the intake heating and distribution of air uniformly throughout the buildings. It had to also take into account such factors as fume exhaust systems, inrush of air through open doors, heat generated by machinery and the need for special air cooling in certain locations.

Figure 5 shows building 1 which is a special case since the steel coils as received are normally warm having come directly from the hot mill. Because of this and because no employees have fixed work stations in this building, no direct heating nor fresh air supply units were installed. The heat from the coils as well as from the adjacent pickle building maintains a comfortable temperature within this building during cold weather. During warm periods, louvers along outside walls together with gravity and power roof vents, maintain adequate ventilation. An automatic door heater is installed over the track and truck entrance located on the south end of the building. When vehicles pass in or out the overhead heater tempers the inrushing cold air.

In building 7, the annealing furnaces generate heat. Air is brought into the basement to cool the coils and is delivered onto the floor above. Therefore the main part of this building does not require additional heaters nor a separate fresh air supply. However, a fresh air supply heater is located at the south end of the building directly over the atmospheric gas generators, and a truck dock at the north end has a door heater.

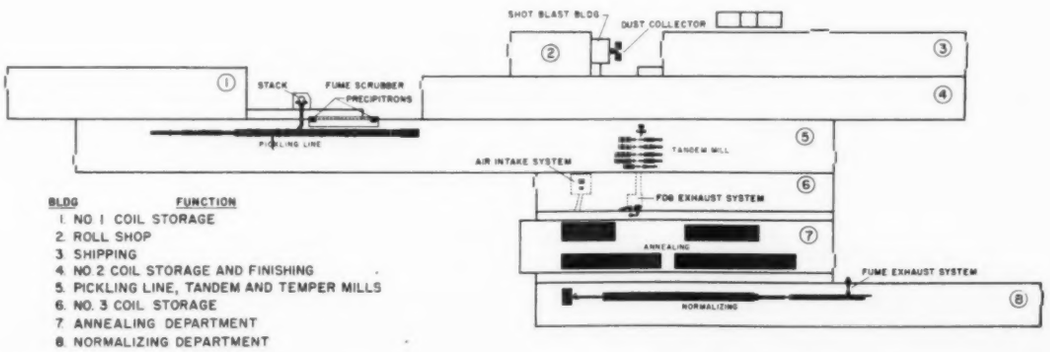


Figure 5 — The cold strip mill is composed of eight buildings enclosing a total volume of 55,000,000 cu ft.

TABLE I
Building Dimensions

Building	Crane span, ft	Building length, ft	Height to crane rails, ft
1	120	552	28
2	100	216	35
3	100	696	28
4	100	1272	28
5	120	1824	36
6	100	696	36
7	120	774	47
8	100	1224	28

The normalizing and pickling lines and the tandem mill have exhaust systems for fume removal. With the special exceptions just noted, the system of heaters and roof vents takes care of the entire job of heating and changing 55,000,000 cfhr of air.

Figure 6 shows the location of the heater units in the system. Solid squares are door heaters; blank circles fresh air supply heaters, and solid circles are recirculating heaters. Triangles represent condensate—utilizing recirculating heaters. The totals are 37 fresh air supply heaters, 25 recirculating heaters and 15 door heaters. Also part of the system are a total of 76 gravity roof ventilators, 21 power roof ventilators and two continuous ridge type roof ventilators above the annealing department.

Figure 7 shows one of the fresh air supply units from the catwalk. These units have a rated capacity of 25,000 cfm except for one in the roll blast leanto which is rated at 12,000 cfm. They heat the air passing through them to a maximum of 110 F even with outside air as low as minus 10 F. Except under remotely possible recirculation operation, they bring in their full capacity of fresh air continuously, summer or winter, heating whatever proportion of it is necessary to maintain 70 F at the floor level to satisfy the settings of the thermostats. The short ducting to the roof is visible in this illustration.

The recirculating heaters also handle 25,000 cfm. Each has a rated output of 1,600,000 Btu per hr with air entering at 70 F. They operate on steam at 100 psi and 400 F.

There are eight additional recirculating heaters, one in each zone, which operate on condensate at approximately 338 F as received from the other units in the zone. They appear almost identical to the standard recirculating heaters, the only difference being a double-deck heater section instead of a single row of steam coils. This increases the capacity to 2,030,000 Btu despite the lower heat content in the condensate fed to it. These heaters save a large amount of heat from the 338 F condensate. They use this heat and finally discharge the water at approximately 215 F. All recirculating heater fan motors operate only when their thermostats call for heat. Thus they run on-and-off to assist in stabilizing floor temperatures at 70 F.

Figure 8 illustrates a typical door heater installation. These particular units are installed above the truck doors at one end of the shipping building. The door heaters are each rated at 25,000 cfm and 1,600,000 Btu per hr. In cold weather, limit switches turn the fan motors on when doors start to open, and off when the doors close. They also have overriding room thermostats which turn them on, whether the door is open or not, if the temperature in the vicinity is below thermostat setting.

There are eight steam pressure reducing stations. The incoming steam supply of 250 psi and 525 F temperature is reduced to 100 psi and 400 F. All reducing stations are located in the truss area readily accessible from the catwalk. Each reducing station serves its own independent zone of the heating system.

From seven of the eight zones, condensate at the final 215 F temperature goes directly to the mill sewer system because the mill is too remote from the steam plant to justify the cost of returning it. From the eighth zone the condensate goes to a storage tank at the floor level near the tandem mill hydraulic equipment area, from which two small centrifugal pumps feed it to the eight reducing stations. This condensate is injected into the 525 F steam at each reducing station to reduce it to 400 F.

Figure 9 shows a typical motor control center for one of the eight zones of the heating system. This particular zone includes three fresh air supply heaters, three recirculating heaters, one condensate—using recirculating heater and one door heater. The fan units in all zones have identical 7½-hp motors, thus simplifying maintenance and spares.

Figure 10 shows a cross section of a revolving-discharge recirculating heater as installed in this mill. The three basic elements are the fan and motor, the heating section, and the discharge. The high pressure type of airfoil fan is especially designed to deliver the required velocity to project heated air from the truss heights to the working level. The heater tubes are seamless drawn copper alloy upon which are mounted flat rectangular fins with close metal to metal contact. The fins are precision spaced by automatic machinery and have low resistance to air flow. Little, if any, dust can collect on the fin surfaces due to their low resistance to flow and to the scrubbing action of the high air velocity.

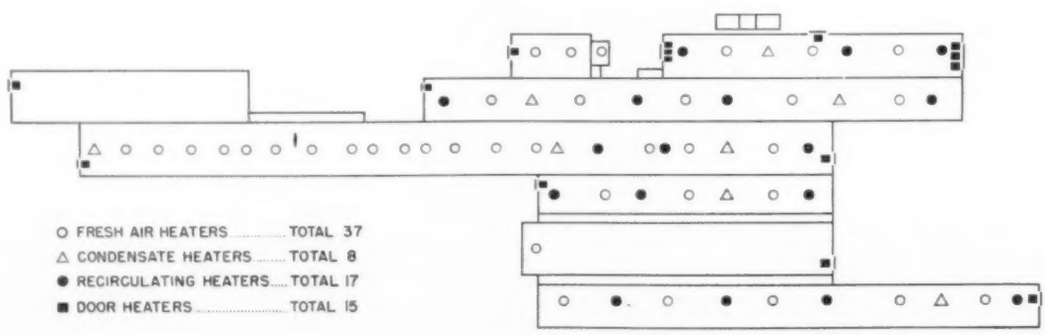


Figure 6 — Types of heaters and their locations within the building are illustrated.

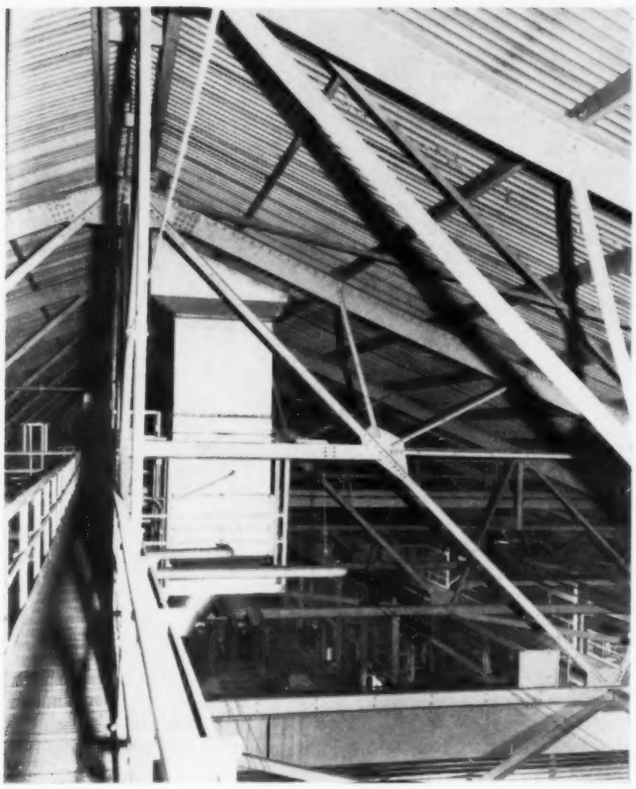


Figure 7 — The heaters are serviced from permanent catwalks.

The tubes are secured to steel headers by positive mechanical joints which permit removal and replacement should any tubes become damaged. Factory inspection of these assemblies includes a hydrostatic test of 1000 psi, and a minimum steam test of 200 psi.

The sheet steel revolving discharge is balanced and turns on a single ball bearing. Its speed is controlled by a small motor and belt. The discharge turns only when the fan is operating. Adjustable deflectors at the discharge outlets permit varying the angle of heat throw to the floor. The condensate recirculating heaters have identical discharges.

Door heaters are essentially the same as the recirculating heaters in construction details, except they do not have revolving discharges. Their discharge is designed for the particular door size and shape. Also it is designed to produce a velocity of approximately 1850 fpm to insure the downward curtain of air penetrating the incoming cold air and reaching the floor. The curtain is not intended to prevent entry of outside air, but to temper it and prevent cold blasts.

Figure 11 gives a cross section of the fresh air supply units as installed. These differ in design from the recirculating type since they must take in fresh air at widely varying temperatures and discharge it at varying controlled outlet temperatures. To achieve this, their heating sections consist of a number of alternate air heating passages and by-passes. Air passing through the openings marked A passes over the heating coils. Air passing through the openings marked B by-passes the heating coils. Each individual passage is provided with a volume control damper. All A dampers are linked together as are all B dampers, and each set is actuated by its own thermostatically-controlled modulating damper motor.

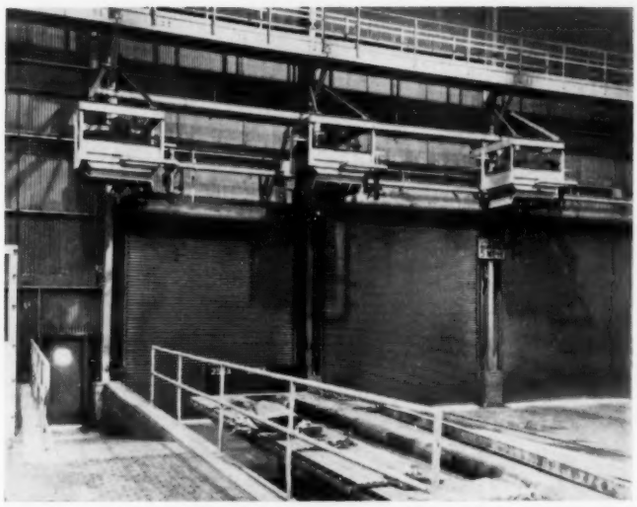


Figure 8 — Door heaters are used to warm incoming air when the doors are open.

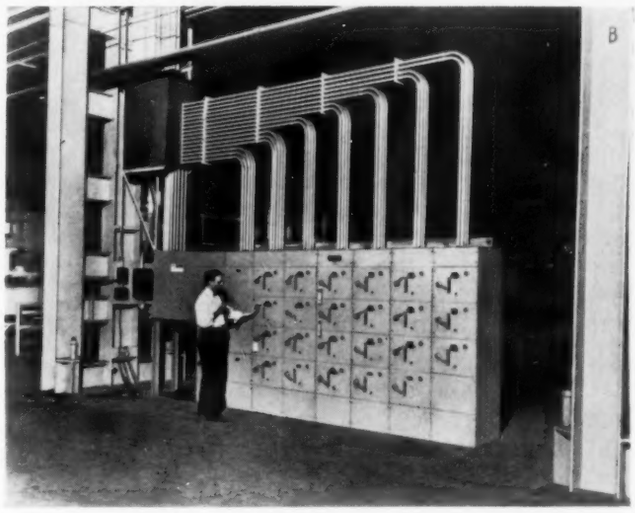


Figure 9 — Each of the eight heating zones has a central motor control center.

Air must pass through the unit regardless of the demand for heat. Therefore, as one set of dampers moves one way or the other, the second set moves oppositely an equivalent amount. The amount of steam used varies directly with the need for heat at the floor level. This is determined by a modulating thermostat, positioning the dampers to vary the proportion of air going over the heating coils rather than through the by-pass openings. In minus 10 F weather all the air would pass over the coils. In summer all of it goes through the by-passes. In between these extremes, when some heat is required, a varying proportion passes through each set of openings.

This unique design was adopted for several reasons. For instance during the heating season a full head of steam is always carried on the coils. This eliminates their being subjected to condensate freeze-up as would be the case if the steam supply were modulated. Moreover, by keeping the coils heated all over, the air is uniformly heated across their face, thus avoiding stratification as would likely happen if there were a temperature gradient resulting from modulation of the steam.

Note the damper in the fresh air supply duct connected to the roof. This damper is power-operated from

a 3-way floor switch which also simultaneously operates the dampers on the side of the roof duct. If the switch is thrown to one position, the fresh air roof inlet damper will close and the recirculating damper will open, thus causing the heater to operate on recirculation. This procedure could be followed in an emergency should the steam supply be cut off or curtailed and thereby be unable to supply sufficient Btu to heat 55,000,000 cfhr of air coming in at a low temperature.

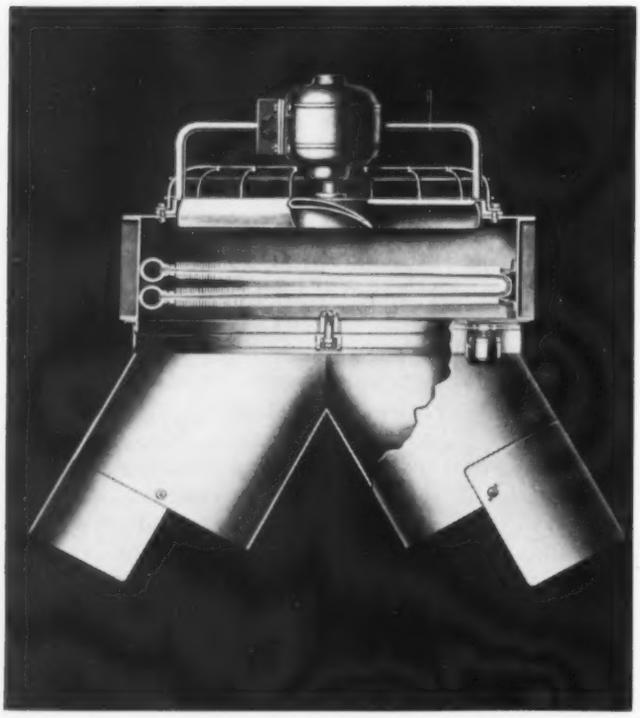
Except for the door limit switches in connection with the door heaters, the controls of door heaters and recirculation heaters are identical and are of room on-off type thermostats.

The thermostat station is generally on a column below the heater it controls, see Figure 12. In this case it is the station for a fresh air supply heater. The location is eight ft above the floor to discourage unauthorized tampering. The larger thermostat is a modulating room-type thermostat, and the smaller unit is a room on-off type.

The system of controls employed is important in order to obtain comfortably close temperature regulation, plus an adequate supply of fresh air for ventilation. The problem is complicated because different buildings or heating zones are open to each other and thereby influence, without control, the temperatures in these neighboring zones. In other words each zone control regulates the heat flow from its own heaters but not directly the heat gain or loss from adjacent zones.

In summer, the recirculating heaters are operated without steam, to promote air circulation. In winter they have only one major function, to help make up heat loss. Thus, their control is simple. As has been said, it consists only of an on-off room-type thermostat. However, the fresh air supply units require additional control since they must both bring in ventilating air regardless of the need for heat, and provide heat as

Figure 10 — The recirculating heater forces the air past the heater tubes at a high velocity, which is needed to deliver the air to floor level.



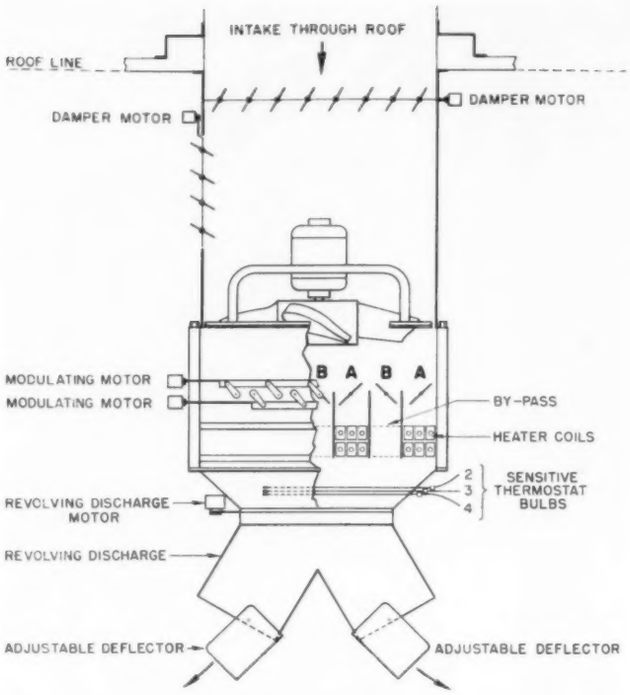


Figure 11 — The fresh air heaters are equipped with by-passes to permit heating of only part of the incoming air.

conditions at the floor may require.

Not shown in Figure 11 is the modulating thermostat located on a steel building column eight ft above the floor level and set to provide 70 F. This instrument modulates the face and by-pass dampers built in the heater coil. Thus as the outside temperature varies, so will vary the proportion of air going through the hot coils or by-passes. In this manner heat is added to the air

Figure 12 — Thermostats are placed eight ft above floor level to discourage tampering.

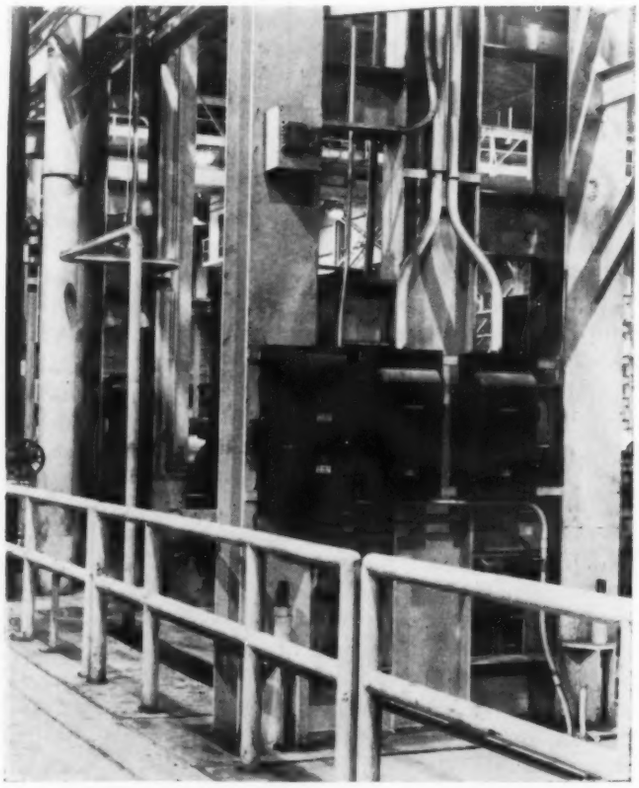


Figure 13 — Recording thermostats were used to check mill temperatures while the system was being adjusted.

only as required to maintain the desired floor level temperature.

Instrument 2, an airstream modulating thermostat used as a limit switch, operates in conjunction with the modulating thermostat to insure the air leaving the coils does not exceed 110 F. This is the temperature found desirable on this job to insure heat reaching the floor. In other installations this temperature could be different.

When the floor thermostat is satisfied and the face dampers largely or fully closed, the incoming fresh air would likely cause the discharge temperature to drop. If the latter should drop too low, the modulating thermostat 3 would reposition the face and by-pass dampers to maintain minimum discharge temperature.

As a safety feature, in case of steam failure while the inlet air temperature was below 40 F, thermostat 4, an on-off type, would stop the fan motor as well as close the fresh air inlet dampers. This motor stoppage would occur whether the operation was on fresh air supply or recirculation.

A fifth thermostat, an on-off type set to provide 73 F, starts and stops the fan motors when the heaters operate on recirculation. It is not shown here since its sensing element is located on the column eight ft above floor level.

On a panel board at floor level is a manual 3-way switch enabling the foreman to operate the fresh air supply heaters on fresh air supply, or recirculation, or shut them off.

When this latter switch is on recirculation, the fresh air inlet dampers close and the recirculation dampers open automatically. The opposite occurs when the switch is turned to fresh air supply.

Please bear in mind that the actual temperatures mentioned in this article apply only to this mill and this particular heater design and could vary somewhat to satisfy the comfort requirements of another mill where the conditions are different.

During the early startup of the system, and before the controls were adjusted, the temperatures varied considerably from point to point in the mill. Helping to cause these wide variations was the uncontrolled heat flow from the buildings open to each other. For these reasons, and because of the need to experience a variety of weathers before the system was "shaken down," final thermostat settings were not completed until well into the first winter of operation. During a representative period of the second winter, with no new adjustment of thermostat settings, regular temperature readings were taken in and outside the plant. Figure 13 shows a recording thermometer mounted on a column near the tandem mill. A similar thermometer was located outside on the north wall of the building in which the tandem mill is located. Three other thermometers, not of the recording type, were located at the shear line, in the roll shop, and at the pickle line. The readings were recorded daily during the severe weather experienced late this past winter. During this period outside temperatures varied between 15 and 45 F.

Figure 14 shows a pair of typical charts, one inside and one outside, taken simultaneously. The functioning of the controls is indicated by the smoother inside curve regardless of the wide variations outside.

Of great importance is the fact that at no given time during the period when temperatures were recorded was there more than a 6-degree difference between widely separated points in the mill. If the somewhat special case of the isolated roll shop is eliminated, the difference would be but three degrees. Thus an employee encounters no chill nor overheating in walking from one location to another, anywhere in the mill.

Additional refinements in individual thermostat settings could be made to further reduce the spread of inside temperatures, but this has not been considered

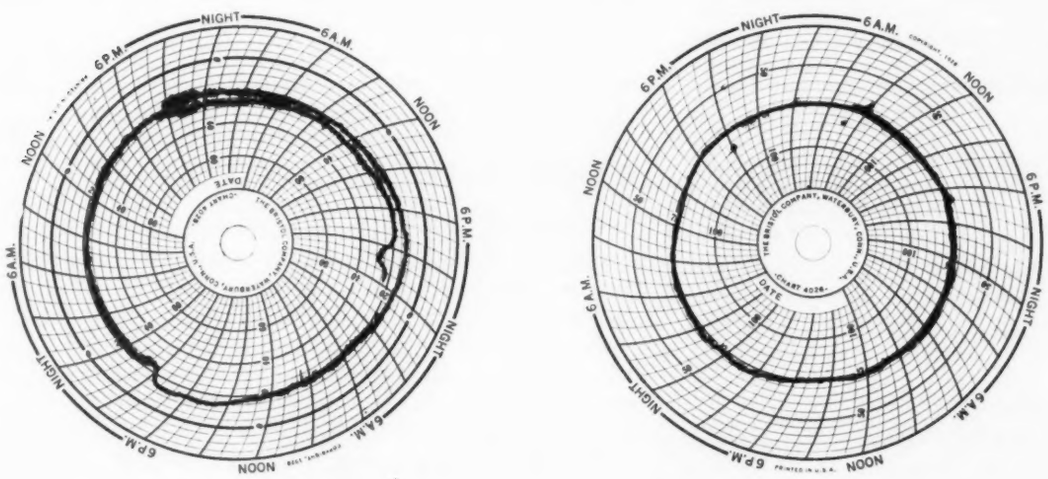


Figure 14 — The charts shown are outside temperature (on the left) and inside temperature over the same period.

necessary since the present range is comfortable.

In the two seasons during which the system has been operating, the heaters have required no major maintenance or repairs, and no major maintenance is anticipated in the foreseeable future. Of course, normal lubrication is necessary.

The following are a few final points on the advantages of the system:

1. Due to a slight pressurization of the mill building from the injection by the heaters of the large volume of heated fresh air, there are few cold drafts or cold spots which cause human discomfort.

2. The gentle air movement from the heaters revolving—discharges adds to human comfort and carries away or evaporates normal perspiration from the body, whereas quiescent air tends to be stuffy and humid.

3. Fresh outside air is constantly being pumped into the mill for ventilation purposes.

4. The widespread and uniform distribution of heat prevents condensation on cold walls and other building members by not allowing the temperature in any part of the mill to drop below the dewpoint. Condensation otherwise could cause much corrosion on both structure and steel products.

5. The same heating equipment is operated in the summer time, with steam turned off, to produce a slight air motion at the floor level.

Discussion

PRESENTED BY

G. W. BETZ, Chief Engineer, Wyckoff Steel Co., Ambridge, Pa.

CHARLES H. SMITH, L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co., Inc., Linden, N. J.

GEORGE RANDALL, Chief Engineer, Ambridge Plant, The National Supply Co., Subsidiary of Armco Steel Corp., Ambridge, Pa.

T. M. HENDRICKSON, Power Engineer, The Youngstown Sheet and Tube Co., Youngstown, Ohio

F. B. BEVELHEIMER, Power & Fuel Engineer, Engineering Dept., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

J. J. MURRAY, Development Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

F. E. TUCKER, Supervisor of Industrial Health Engineering, Research and Development Dept., National Steel Corp., Weirton, W. Va.

ROY SCHWARTZENTRUVER, Combustion Engineer, Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.

WILLIAM H. HUNTER, Superintendent, Mechanical Dept., Ambridge Plant, The National Supply Co., Subsidiary of Armco Steel Corp., Ambridge, Pa.

G. W. Betz: The heating installation, described by the author is just about the ultimate in mill building heating in consideration of all the variables. In experience with a mill producing a finished product, there are thousands of tons of steel in process at all times which is subject to oxidation if the temperature goes below the dew point, which makes the first consideration in heating that of protecting the product. Due to the difference in first cost of the revolving discharge over the fixed discharge heater for equivalent output, it was attempted to evaluate the differences in order to justify the additional cost. It was found that for buildings that did not have very many personnel, the fixed discharge heater was ample for supplying heat to the product, but in buildings where a lot of men were working it was not at all satisfactory. Men working in an area that received a hot blast would turn the heater off, causing everyone in that particular area to be cold. The revolving-discharge heater proved to be more uniform in heat distribution and satisfactory to all the personnel. This also proved true in warm months when the heater fans are used for air circulation.

Some years ago it was attempted to overcome the infiltration of cold air at door opening in the shipping building by increasing the size of the heaters, which caused the size of the heaters to be considerably larger than needed if there were no door openings. As these are replaced they are sized for the building heat loss neglecting the doors, and an overhead door heater heats incoming air.

Charles H. Smith: If there are few workers present and the materials in storage are so arranged that the heated air from fixed discharge heaters is not blocked to prevent good distribution, such design of heaters should prove quite adequate as Mr. Betz has found. If, however, the storaging is such that the heated air from the fixed discharges could not reach all the nooks and crannies where oxidation could occur, then the revolving type could be highly recommended to reduce or eliminate losses from corrosion.

The discomforts to workmen caused by fixed discharge units led to the developing of the revolving type as a solution for both summer and winter usage.

Wherever there might be a heavy infiltration of cold air through leaks or open doors due to the building being under a negative pressure, it would be beneficial to add some fresh air make-up supply units.

George Randall: The author stated that 110 F was the maximum temperature of the air leaving the coils and that this temperature was the most desirable in this particular job to insure heat reaching the floor. Can the author give some information as to how to arrive at this figure? It seems that with the roof trusses varying between 40 and 69 ft in height that there would be some considerable variation of air temperature reaching the floor.

Could the author give an idea of the cost of such a heating and ventilating system on a sq ft or cu ft basis?

Charles H. Smith: Mr. Randall asks how the 110 F heater discharge temperature was determined. This temperature was not a design objective but rather an observation. In other jobs, this maximum could be higher or lower. It is to be remembered that the force of the air from the fan limits the distance that heated air can be delivered to a floor against the rising tendency of the heated air. Thus, if this temperature is too high, the air might stop and turn around before it

reached the floor. Obviously some control over the maximum temperature is necessary and bulb 2 provides this control. In other words 110 F has been found for this job to be the upper limit that the air can be heated and still be made to reach the floor by force of the fan.

The original outline for this article listed system costs as an important item to be included for it is a question occurring to many. However, the various parts of the installation work were performed by different contractors: erecting the units; doing the piping; the wiring work; catwalks, etc. Furthermore, the costs of the heating work and the ventilation were not kept separate from those of other items in each contract. It was not possible to obtain authentic figures. Therefore, it was deemed advisable to omit all cost figures since it was felt that guesswork would have no place in an article of this type. It should be pointed out that the customer looked into and considered other methods and heating systems before deciding on the revolving-discharge type.

T. M. Hendrickson: The type of circulation which is effected by the overhead revolving-unit heaters should be re-emphasized. It was pointed out that less stratification would occur resulting in less temperature difference between floor and roof. This is definite savings in heat loss at the roof and yet maintains a controlled uniform temperature at the working level. It is essential that this point be understood, so as to rule out any possible skepticism which might infer that these units are heating the air up under the roof instead of at the floor where it is wanted.

The condensate heaters which are installed, one approximately for each eight steam heaters were said to be controlled by a standard on-off thermostat located at the floor level. Would it not be more desirable to have them controlled by an aquastat located in the discharge line from these condensate heaters. This would insure maximum heat extraction and avoid unnecessary flashing in the condensate waste system. It is believed that the controls on the steam heaters would be sufficient to maintain uniformity of temperature at the working level throughout the building without appreciable effect from this type of control on the condensate heaters.

In the annealing building only a door heater and one overhead fresh air revolving unit are installed, the latter for spot heating at the atmospheric gas generating station. The balance of heat will normally be provided by the annealing furnaces. If for any reason only a few furnaces or none at all are operating, the effect of one unit of the overhead revolving type for spot heating purposes would be questionable.

Charles H. Smith: A simple thermometer reading at floor level will dispel skepticism about uniform temperature. In addition, watching a small piece of paper flutter around the floor from the force of the discharge air will dispel doubts about distribution.

It is also interesting to observe temperatures at regular intervals between the floor and the roof. These will show about 0.25 F difference per ft of rise. When heated air is discharged near the floor level the rise to the roof averages 1 F per ft or more, causing high temperatures and stratification just below the roof.

Mr. Hendrickson asked about using a condensate return aquastat for controlling the condensate heaters instead of an on-off thermostat. To my knowledge this has not been tried; however, it should reduce the temperature of the condensate going to waste. It would be assumed there was adequate coil surface in the heater to insure condensing all of the steam flow. It would seem that the floor thermostat would still be needed to prevent the heater from running when the floor temperature was adequate. This suggestion should be tried out at the first available opportunity.

It is assumed that the separate air supply to the furnaces would be turned off since there would be no need to do any cooling. If the outside weather was cold enough to cool the entire building below a comfortable working temperature, spot heaters would be desirable. Perhaps the capital costs for additional heaters would have to be considered vs the chances of the annealing furnaces being shutdown in severe weather.

F. B. Bevelheimer: There has apparently been a great deal of thought given to the problems encountered in maintaining this equipment which has been installed in the roof trusses. The system of service walkways appears to be adequate. Past experience has indicated that this type of installation is difficult to maintain. With a much less complicated system of space heating, it has been almost impossible to maintain all units in operation 95 per cent of the time. Steam heated units in this location with their series of fan motors, heating coils and traps have always been a source of trouble. While a constant patrol of the catwalks will detect any equipment not in service, the main problem is to get maintenance people to service this equipment.

Experience has indicated the desirability of installing space heating at floor level using steam heat or direct-fired unit heaters for the heating system. With the type of maintenance and the maintenance personnel available today, there has been difficulty in maintaining even the floor units which are readily accessible. In one instance where space limitations would not permit the installation of floor type heating units, gas-fired radiant units were installed above the bottom chord of the roof trusses.

Charles H. Smith: To avoid shutdowns from steam traps, good practice recommends installing two traps in parallel so that if one clogs, the condensate can still pass through the other. The traps can then be inspected and cleaned in the summer time in regular maintenance schedules. The use of presealed lubricated bearings on the heater motors reduces normal servicing to once in several years. Heating coils can cause troubles if there is no provision for freedom to expand and contract with changing steam or operating temperatures. These are items within the control of the equipment manufacturer. The revolving discharge can largely be discounted as a source of trouble. There is no wear on its presealed ball bearing which turns at approximately 1½ rpm. While floor-mounted units are more accessible for servicing, they are likewise more subject to damage from traffic. Furthermore, with floor space costing from $6 to $10 per sq ft, there is a considerable annual savings with ceiling mounted units from the space cost angle.

J. J. Murray: Only one air-change per hr has been provided. References indicate that from six to twelve changes per hr are necessary. Is one change sufficient?

In the described system, what proportion of the air is recirculated? With the damper controls provided, is the system able to supplement the one air-change per hr with additional fresh air supply, especially for summer ventilation?

It has been stated that because of pressurization of the building, cold spots and drafts have been eliminated. In the experience with these buildings, has this been found to be true during periods of high wind velocity with resulting infiltration of outside air?

This is essentially a custom installation. Considerable thought has been given to the design. It would be of interest to know the cost of the installation as well as the operating cost.

Charles H. Smith: A proper answer to Mr. Murray's comment is dependent upon a number of factors which when evaluated will automatically indicate the number of changes needed.

Let us first determine for what purposes the fresh air is required. These are principally as follows: (a) for respiration of the employees, (b) for removal of perspiration from worker's bodies, (c) for combustion air for any fuel-fired process heating equipment and (d) for replacement of any contaminated air resulting from processes.

In a modern steel mill building exhaust systems are most always provided to remove contaminants that might be exuded in any volume. With reference to the mill under discussion, it was pointed out that exhaust systems are employed over the normalizing and pickling lines and in the tandem mill. In the shot blast building there is a dust collector. Contaminations beyond these are of nominal amount. There are no sizable combustion processes to require venting. Thus the fresh air supply is principally for the comfort and health of the employees. In a modern plant where operations are largely automatic, the number of men per sq ft or cu ft is very small. Thus one change per hr has proved adequate for the few employees involved.

It is not feasibile to give a percentage relationship between fresh air supplied and the quantity recirculated. The fresh air supply is constant, winter and summer, whereas the amount of recirculation varies with the outside temperatures. Thus the relationship will likewise vary with the weather. It can also be appreciated that due to individual on-off thermostat control, the number of recirculating units operating varies widely. With respect to possible cold drafts from high outside wind velocities, the modern construction of the buildings protects against such. The only openings of any consequence, since there are no windows, are the outside doors for access by trucks, freight cars or employees. High outside air velocities could, of course, force air through these doors when they are opened. However, any such effects are mitigated by the overhead door heaters, which operate automatically whenever the doors are opened.

F. E. Tucker: The heating and ventilating installation described by the author represents an excellent example of modern steel plant heating and ventilating. It appears that heavy industry has come to realize the advantages of make-up air ventilation in contrast to the old practice of attempting to exhaust ventilate large mill buildings. National Steel Corp. has installed make-up air heating and ventilating systems totalling 3,000,000 cfm of air capacity, and is presently installing an additional 1,000,000 cfm of make-up air capacity.

The advantages of installing large make-up air systems are many. Engineering design must not only consider the mechanical and physical parameters of mill construction, which is only a part of the ultimate operation, it must also recognize the complete "man-machine system." With present day advances in machine design, we have made "man" the weakest link in the "man-machine system." Since it is not possible to improve the human design, our only hope of strengthening the system is to improve man's environment. One way to improve his environment is through better heating and ventilation of the work area.

The key to good make-up air ventilation is distribution. It is not enough to merely pump air into a building. The air must be distributed throughout the work area so that the employees working at floor level receive maximum value per cu ft of air supplied. This is the part of the system described by the author which, depending upon building design and usage, represents both the strongest and weakest feature of the system.

On the plus side, this system utilizes a revolving discharge outlet which the manufacturer claims sweeps a circle 100 ft in diameter, bathing the employees within the circle with warm air during winter and outside fresh air during summer. This is an excellent feature and is valid as long as the building being heated does not enclose a large heat or fume source. In this case, the natural upward flow of heat and fumes will be interferred with and quite possibly concentrated at floor level.

For this reason, at a new installation, National Steel Corp. has chosen to make a combination installation. In building areas where summer heat loads are not critical, revolving-discharge heaters were installed and in areas where heat is critical, 75,000-cfm composite heating and ventilation systems were installed. With these composite systems, the heating unit and fan are located in the roof trusses, but air is supplied to the floor through vertical ducts which discharge all air at the ten-ft level around the perimeter of the buildings. Air is supplied to all areas at a rate of two cfm per sq ft of floor area which is equivalent to twelve air changes per hr at this level. The control system on these units is comparable to that described by the author.

In designing heating and ventilation systems, it is well to keep one objective in mind—the employee. This limits consideration to the lower ten ft of any building regardless of size. All of our employees, with the exception of crane operators, work at floor level, and the temperature of the air at the 20, 40, or 60-ft level is of no consequence in considering employee comfort. Where necessary, overhead crane cabs can be supplied with individual air conditioning units.

The author has stressed the importance of system maintenance and repair. It is no more difficult or time consuming to maintain a large system than a small one. For example, a 50,000-cfm system requires identically the same number of man-hr of maintenance as one of 5000-cfm capacity. Therefore in design, if one 50,000-cfm unit can replace ten 5000-cfm units in the same building, maintenance costs are reduced by a factor of ten. In an economy where man-hr for maintenance represent an increasing percentage of over-all employee

costs, this factor becomes increasingly more important.

Each new building and facility presents a different set of requirements for heating and ventilation. No single system or specification will meet all of these requirements. Specifications must be flexible enough to permit installation of the system best suited to meet the requirements of each specific set of conditions.

Charles H. Smith: Mr. Tucker appropriately emphasizes that in a "man-machine system" improving man's environment through heating and ventilating is of the utmost importance. It is also important to furnish tempered air to machinery to prevent corrosion or undue expansion or contraction from wide temperature variations.

Additionally is the need to uniformly distribute the tempered air, which can be accomplished by the use of revolving discharges.

Where an important source of contamination is present, it is advantageous to provide the fresh air outlets close to the floor level to prevent mixing of the contaminants. If the volume of the contaminant is large, it would be advisable to install a separate hooded exhaust system. While it was not so stated it is assumed that the outlet designs ten ft above floor level would encompass air velocities low enough to prevent uncomfortable blasts upon any workers in the paths of the discharges.

The principal target of the heating and ventilating design is the employee who spends most of his time within ten ft of the floor level. This heat will of course rise to the roof by gravity and if not redelivered to the floor level, high temperature stratification will ensue.

In stressing the importance of system maintenance and repair, Mr. Tucker pointed out the economies in servicing a few large units vs a multiple number of small ones. It is felt that the designer can go overboard in either direction. For example a simple example of such would be to provide a single large heating and ventilating unit with its output distributed by many space consuming and expensive ducts, vs a large number of small units placed along sidewalls at close intervals. The cost of servicing the one large unit should be less than the many small units. Some reduction in this saving would result from maintaining the ducts. An important weakness in the single unit design is the possibility of complete plant shutdown should there be a mechanical failure of the single unit. An additional weakness is the high cost of power to force heated air through the extensive duct system, which is itself an expensive item.

Cost comparisons in numerous instances have indicated substantial savings in capital and operating costs through the use of the revolving heater system which is a compromise between the two theoretical cases.

Every job must be separately engineered to meet the requirements of specific conditions.

Roy Schwartzentruver: It has been the practice to favor the cold end, or the prevailing wind end of the building, to overcome the additional heat loss at that end. In the mill heater layout shown, no provision was made to favor the prevailing wind end of the building. How is this accounted for? Is it a pressurization of the building by use of the fresh air supply units, or is it the utilization of door heaters at the prevailing wind end of the building?

Charles H. Smith: Perhaps the most important factor in balancing heat losses where one end of a building is overly cooled due to high velocity winds at that end, are the recirculating heaters. Each one of these has its own on-off floor thermostat and if any part of a building, such as an end, cools unduly, regardless of the cause, the recirculating heaters in the cooled area operate more frequently or for a longer period to maintain the desired temperature.

Help in this effort is also received from the fresh air units since their individual thermostats of the modulating type will also feel the cooling effect and they will cause the heater dampers to be repositioned so that more air travels through the heater coils and less through the by-pass. This results in a higher outlet air temperature which continues until the floor temperature is restored. Thus extra cooling from high velocity outside winds is automatically corrected.

It is likewise correct that the slight pressurization of the building from the fresh air supply units also helps since infiltration from high winds is checked thus eliminating cold drafts through leaks.

Similarly the door heaters lend an assist by tempering any cold air that tends to enter when the doors are opened, and by automatic operation in maintaining the desired ambient temperature in the vicinity of the doors even when they are not opened.

William H. Hunter: The installation of catwalks and platforms to and around all heating units is certainly an excellent feature from the standpoint of safety and worker accessibility. If heater failure occurs during the operating week, the heater is turned off until the weekend for repairs, so the productive work of the overhead cranes is not delayed. Access to the majority of the heaters is with a step ladder from the crane bridge.

The author talked about the ultimate in heating and ventilating: new mill buildings, high bays and a design with the worker's comfort and health given every consideration. A great majority are faced with the problem of heating old buildings which have been converted over the years from storage to producing units, and which were designed with worker comfort given little consideration. Such buildings are usually spot heated, that is putting the heat in the location where the majority of the workers will be concentrated.

Charles H. Smith: The vast majority of installations in older buildings do not have catwalks or service platforms. The latter are generally confined to new construction where these conveniences can be installed at low cost. In large jobs, catwalks have numerous cost saving advantages in addition to servicing, such as lower mounting, piping and electrical costs. Also, it is easier to paint the roof and trusses as well as make roof changes or repairs.

The system described in this article is the ultimate in heating and ventilating. Similar results can be obtained in old buildings although the heating required would be greater because of the poorer construction and leaks and openings usually present in older buildings.

However, where a reasonable number of employees have work stations in an older building, the cost of a first class heating system can be justified. If there are but a few employees, then spot or fixed discharge heaters might be justified from the standpoint of lower capital costs. ▲

Symposium on Fairless Works Open Hearth Shop

....the extended use of oxygen in the open hearth has reduced tap-to-tap time while increasing both furnace temperature and waste gas contamination....yet application of the sprung basic roof has extended furnace life, while careful and continuing modifications of the existing precipitators have reduced air pollution....

OXYGEN LANCE INSTALLATION AND PRACTICE

by W. E. BRANDT
Assistant Division Superintendent
Open Hearth Div.
Fairless Works
United States Steel Corp.
Fairless Hills, Pa.

IN the continual effort to increase production without expending excessive amounts of money for the construction of new facilities or the radical alteration of existing equipment, steelmakers have experienced with many techniques and ideas. One of the most successful endeavors has been the development of the oxygen lance. This article covers a description of the lances and experience with the use of oxygen at the Fairless works of United States Steel Corp.

Like most successful processes, the oxygen lance went through a series of modifications and refinements before the present design was evolved. Prior to the development of the oxygen lance practice, oxygen was used for decarburization in the production of soft or low carbon steels, by blowing oxygen through a 1-in. steel pipe into the bath. Due to splashing and fuming at high carbon, this practice is generally employed at about 0.30 per cent carbon or under. Although this practice is in current use in some plants, it has several disadvantages. The 1-in. steel pipe is rapidly consumed, the pipe must be fed manually into the bath and the connecting hoses and pipe interfere with charging buggy movements in front of the furnace.

Oxygen has been used for flame enrichment during

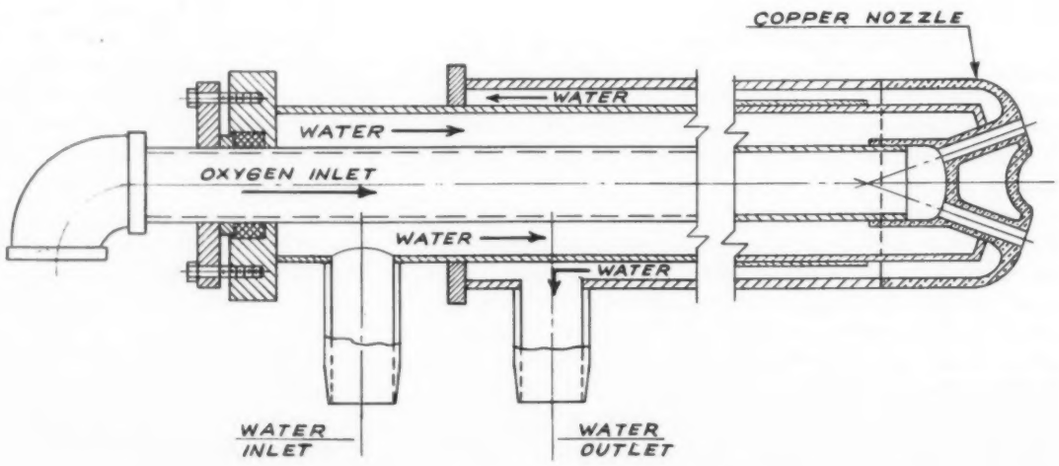


Figure 1 — Cross section of the oxygen lance indicates the flow paths of the oxygen and the cooling water.

Figure 2 — The lance has three major component parts.

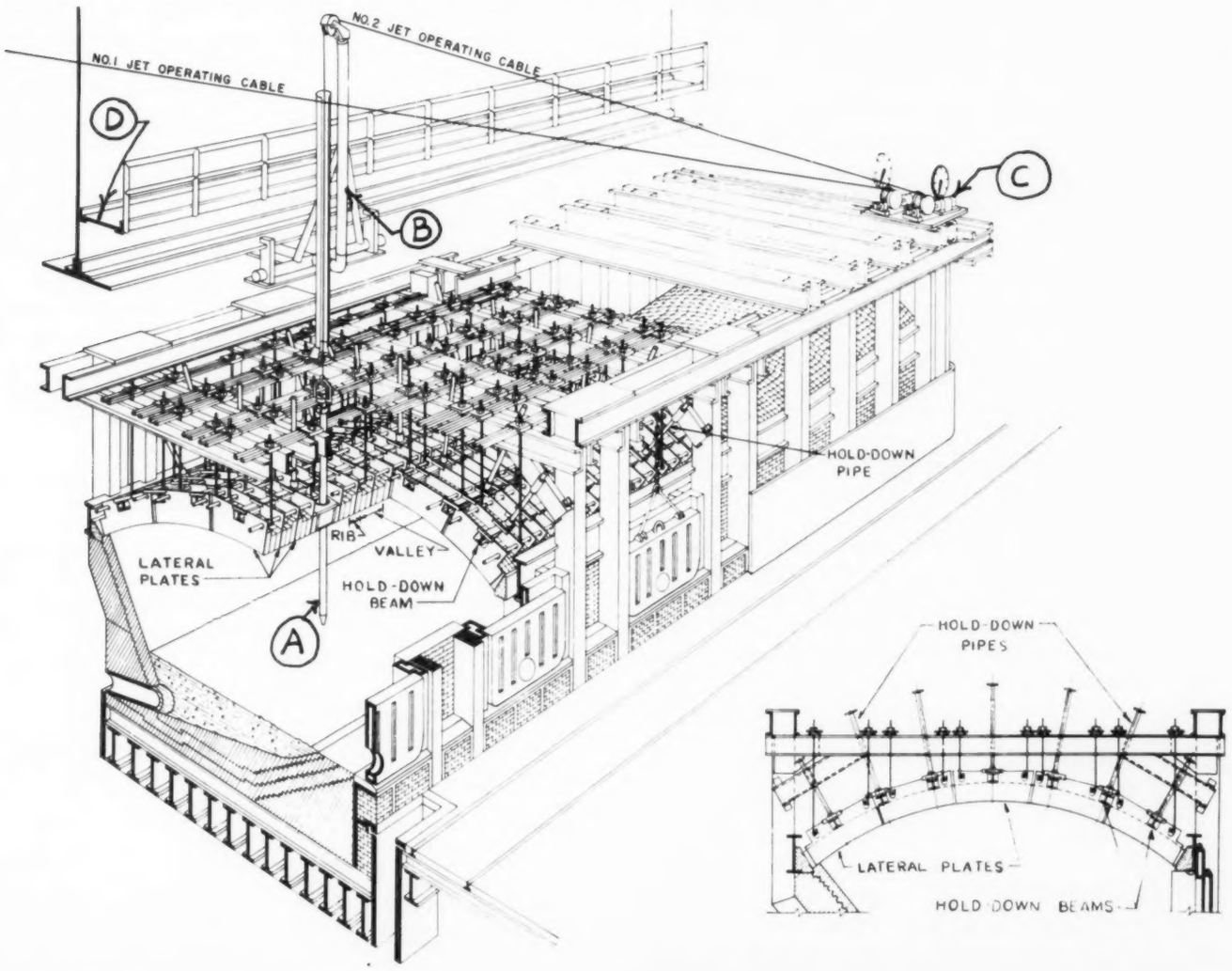
the charging and melt-down period in plants having a high scrap charge. This oxygen is introduced through a nozzle of the furnace burner.

Numerous other methods have been tried including oxygen jets that pivoted into the furnace through ports in the backwall. With each, difficulties were encountered to a degree that dictated continuing the search for a better way. One adverse feature of these devices was the splashing of metal on the brickwork with resulting damage to refractories.

The problem of splashing was successfully overcome by the use of lances that hang through the roof of the furnace and blow down onto the bath. In 1954, the first oxygen lance was installed on No. 28 furnace in open hearth No. 4 at the South Chicago works. Today roof lances are installed on 73 of the 256 open hearth furnaces in the United States Steel Corp. At Fairless works the first roof lance was installed in the summer of 1956. Through a period of development there was a progression from a single lance installation to double and triple lance installations. The data from each trial were evaluated, and as a result two lances per furnace are used as a standard installation.

Figure 1 shows a cross section of the present oxygen lance. The oxygen lance now being used is made of three concentric steel pipes with a high conductivity cast copper nozzle welded to the inner and outer pipes. Oxygen flows through the 2-in. center pipe and out through six ports in the copper nozzle. Cooling water enters a 4-in. pipe jacket, flows down along the 2-in. oxygen pipe and is channeled around the ports of the copper nozzle by a deflector sleeve. It then flows back up through the outer 6-in. cooling jacket and leaves the lance. Metal clad flexible hoses connect the oxygen inlet, water inlet and water discharge to their respective piping. Figure 2 shows the three major components of a lance ready for assembly: the 6-in. outer

Figure 3 — A catwalk along the length of the shop permits easy lance maintenance.



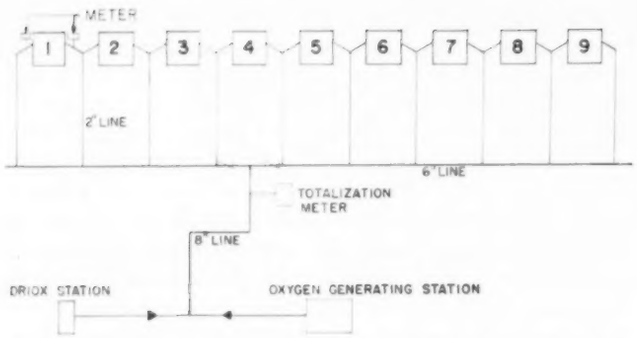


Figure 4 — Total available oxygen is 750,000 cfhr at 150 psi and 99.5 per cent purity.

jacket, the 4-in. inner jacket with deflector and the center oxygen pipe with cast copper nozzle attached.

Two oxygen lances are used per furnace as shown in Figure 3. Each lance (A) is suspended from a fixed mast (B) that is attached to the crane girder. A winch (C) that raises and lowers the lance is located on the steel work above the port roof. The winch has an electric drive with a fluid coupling between the motor and the cable drum. The fluid coupling will slip if the lance becomes jammed or engages the mechanical stop located below the sheave on the mast. With the fluid coupling drive no cables have been broken because of excessive stress. However, a safety chain is attached which prevents the lance from dropping into the bath, should cable failure occur.

Lance elevation is controlled from a push button located on the furnace panel board. Pressure gages and flow meters for each lance are also located on the panel boards. Mercury pressure switches installed on the water and oxygen feed lines are adjusted to automatically retract the lance if either water or oxygen pressure falls below predetermined settings.

A catwalk (D) is installed approximately eight ft below the lance sheave to permit easy lance change. The water inlet, outlet and oxygen feed pipes are located on the catwalk so that hose changes can be made readily. This catwalk extends the full length of the shop providing access to all lances.

A general plan of the oxygen distribution system is shown on Figure 4. The primary source of oxygen for these lances comes from an oxygen generating station. An auxiliary liquid oxygen converter provides oxygen during peak demand periods and bulk station outages. These stations are capable of delivering 750,000 cfhr of oxygen at a guaranteed 99.5 per cent purity and a pressure of 150 psi. The incoming oxygen line to the open hearth shop has a meter which records the total flow and automatically compensates for pressure and temperature changes. Meters located on each furnace panel board record the flow rate and pressure of the oxygen in each of the two lances.

The open hearth process is dependent upon high temperature oxidation. The heat required can be delivered to the bath in two ways:

1. Burner fuel and preheated combustion air.
2. Exothermic reactions of oxygen with bath impurities including silicon, manganese, phosphorus, carbon and iron.

The heat transfer to the bath which is obtained from the fuel and combustion air is dependent on bath activity and the effective difference between the temperature of the flame and the bath. Normally the activity of the bath decreases as bath temperature increases and the rate of heat input is slower as the refining of the heat progresses, since the difference in temperature is less. Conversely, the heat which is derived from the oxidation of the bath impurities is quite high and is transferred directly to the bath.

Calculations have shown that 20,000 cfhr of oxygen to the bath has the equivalent oxidizing effect of 6000 lb of feed ore per hr. The amount of feed ore used is dependent upon bath temperature, and unless the temperature is sufficiently high over feeding will make the bath quite sluggish, thereby retarding the rate of refinement. Because gaseous oxygen does not have the limitations of iron ore it is a more efficient source of heat for raising bath temperature.

In actual practice the furnace is charged in the conventional manner with limestone, ore, scrap and cold metal when used. The optimum rate of production is attained when a 70 to 80 per cent hot metal to ingot ratio is maintained. The oxygen lances are inserted to the slag level after the addition of hot metal to the furnace, and are kept in the furnace until tap. A constant rate of oxygen injection is maintained throughout the heat. The flush is rapid averaging 60 to 90 min for a 345 to 400-ton heat. Due to high rates of reaction the temperature and carbon content of the bath must be under constant control. Two hr after the addition of hot metal the bath is tested for carbon and temperature. From this point a set schedule for carbon and temperature determination is maintained until tap. Carbon content is determined by taking pencil tests for quick determinations in the carbometer. Combustion carbon checks are made as necessary. Temperatures are obtained using a spoon thermocouple below 2800 F and the immersion thermocouple at higher temperatures. During the working period the bath temperature is controlled by increasing or decreasing fuel, or by the addition of lime or feed ore, depending on bath conditions.

The data and experience from the use of oxygen lances have been evaluated and the following facts established:

1. Tap-to-tap times are significantly reduced.
2. Production rates are increased.
3. Fuel consumption is reduced.
4. The metallurgical quality of the product is improved.

Table I shows the results of 44 heats with oxygen and 20 heats without oxygen. Very few heats are now made without oxygen so it is somewhat difficult to make comparisons of oxygen and nonoxygen heats with

TABLE I
Oxygen vs Nonoxygen Furnace Performance

	Oxygen	Nonoxygen
No. of heats	44	20
Heat size, tons	338.2	341.1
Limestone, lbs per ton	65.27	63.7
Ore charge, lbs per ton	246.0	282.9
Production rate, tons per hr	41.26	34.64
Oxygen consumption, cu ft per ton	445.6	...
Time charge-to-tap, hr	7.28	8.74
Time tap-to-tap, hr	8.52	9.97
Fuel, mm Btu per ton	2.47	3.31

all other factors remaining constant. The chart shows a decrease of 1.45 hr in tap-to-tap time when oxygen is used. Another interesting aspect is that there is a decrease in fuel use of 840,000 Btu per ton which is approximately a 25 per cent reduction. This reduction is accomplished by an exothermic reaction of oxygen with carbon resulting in a release of carbon monoxide which serves as a fuel. It is significant that the difference in charge-to-tap time in oxygen vs nonoxygen heat is 1.46 hr as compared to the difference in tap-to-tap time of 1.45 hr. This indicates that there is no appreciable time lost to charging, furnace delays, etc.

An increase in production rate of 6.62 tons per hr can be attributed to the decrease in tap-to-tap time. The charge of limestone remains essentially the same but the feed ore charge is reduced by about 15 per cent.

Heat size in both sets of figures is as close as can be obtained for comparative study. Other contributing factors were held as constant as possible for these heats.

There are other facets of oxygen lance use that are not as apparent as those mentioned above. For example, sulphur elimination performance is improved by the use of the oxygen lance. Slightly lower final sulphur analysis is obtained resulting in a better quality steel for the customer because of the enhanced ductility and formability of the product. The use of the oxygen lance has made it necessary to develop an economical basic roof construction to withstand the higher temperature involved. This has contributed to the economic gains made by oxygen lance furnaces.

In summation, the use of oxygen lances, by aiding high temperature oxidation and heat requirements, has proved to be successful in increasing open hearth production with a nominal capital expenditure for additional facilities.

Discussion

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J. W. Leming, Jr.: Did the use of the oxygen lance increase the steam generation on the boiler, and did it greatly increase the dirt problem in the boiler? Also, do you treat the water which cools the oxygen lance?

C. W. Dunn: The boiler efficiency has more than kept pace with the oxygen lance furnace. We recover roughly a million Btu in steam per ingot ton and on the new furnaces this represents 45 per cent of the gross fired fuel. As the fired fuel has decreased in Btu per ingot ton the effort has been forthcoming to recover a greater percentage of the waste heat available in the boilers, so that the over-all efficiency of the process has increased more than the decrease in fuel fired. The steam output has increased enough to provide the same quantity of steam per ton produced as previously obtained with the nonlance furnace; hence, the reduction in fired fuel per ton has resulted in creating an increased over-all efficiency.

Before the lance became a reality, work on method improvement to clean the gases and improve boiler efficiency had started, so when the lances were installed the rest of the job was done. The 250-psi air soot blowing program was accelerated on both the fired tubes in the saturated section and in the superheater tubes, in order to enable the boiler to stay on for the entire campaign of 400 to 500 heats on the basic roof.

The normal service water, which is pumped from the river in the 60-psig system arrives on the open hearth floor at approximately 35 psig and is used on the lances for cooling. We chlorinate for algae control only in the plant distribution system and no special chemical additions are made for lance operation.

H. W. Potter: What necessary safety equipment is needed and how many interlocks are absolutely necessary in operating the roof jets safely? Is the jet retracted automatically, in the event the water should fail while it is in the furnace?

W. E. Brandt: There are four safety features on the oxygen roof jet installations. A safety chain is attached to each jet to prevent the jet from falling into the bath in case of a cable failure. Second, there are mercury pressure switches which automatically retract the jets in case of water or oxygen failure. The button arrangement that manually controls the raising and lowering of the jets is the third safety feature. The button that raises the jet from the furnace protrudes out. A man has only to touch this button to raise the jet, while the button that lowers the jet into the furnace is recessed. A man has to feel for this button and press it to lower the jet down into the furnace.

The fourth safety feature on the jet installations is the quick shutoff valve for water. This valve is located at the end of each furnace.

E. Eldrett: Does the difference in weight between the oxygen and nonoxygen heats indicate a loss in yield, and if the loss in yield over the conventional yield has been noticed what has been done about it?

W. E. Brandt: A decrease in yield while using oxygen through the roof jets has been experienced. The difference in heat size of 338.2 tons per heat for oxygen heats compared to 341.1 tons per heat for nonoxygen heats as shown in Table I cannot all be attributed to yield loss. Some of it is normal variation in heat size.

J. Trenner: What method is used to retract the lance from the furnace in the event of a total electrical power failure?

W. E. Brandt: There has never been a complete

failure. If a power failure occurs, it is not important to retract the lances immediately. The lances can be left in the furnace and the heat continued while the length of the electrical outage is determined. If it would be an excessive outage, the lances can be left in the furnace, and the flow of oxygen reduced. Only enough oxygen would flow to keep the oxygen ports open. If it became necessary to retract the lances from the furnace, it could be done by attaching the lance cable to a forklift or payloader, which would pull the lance out of the furnace.

J. Hannigan: Is there any decrease in yield with the use of oxygen; also, were Btu or rather equivalent Btu evaluated from oxygen? Is the decrease in fuel oil (840,000 Btu) primarily due to fuel cutback while using oxygen?

W. E. Brandt: Equivalent Btu are not calculated from oxygen. Oxygen is measured in cu ft per ton. The fuel reduction is basic. Firing rates are not cut back while using oxygen. The fuel reduction is associated with the shorter heat time. The furnaces are fired for a shorter period of time; therefore, the Btu per ton are lower.

INSTALLING A SPRUNG BASIC OPEN HEARTH FURNACE ROOF

by K. D. BARTELS

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SEVERAL steel companies have installed basic open hearth furnace roofs of a suspended design during the past 20 years in an effort to overcome the temperature limitations imposed by silica brick. In all cases the furnaces operated above normal in production and in roof life, but when final summations were made, higher installation and operating costs prevented the universal adoption of such construction. In silica brick roofs small quantities of basic brick used in combination with the silica in an alternating pattern in areas of severe wear performed well in most instances, but such compromises did not remove the silica brick temperature limitation. The noticeable decrease in roof life when oxygen roof lances were adopted as a standard steelmaking tool plus the successful performance of sprung basic roofs in Europe prompted the trial of a section of sprung basic roof on an open hearth furnace at Fairless works in May, 1957.

Although the trial section failed after 91 heats, a full main roof was installed embodying principles developed from the trial. All nine open hearth furnaces at Fairless works have been equipped with sprung basic roofs since January, 1959. The features of the roof construction have remained virtually the same as in the first knuckle-to-knuckle roof. Figure 3 illustrates the basic principles of the construction showing the brickwork, the plates and the beams and jacks that hold the brickwork down as well as up. The essential features of this construction are:

1. The rise of the roof arch should be 2-in. per ft of span or greater.
2. The basic brick are chemically bonded with external and internal plates in the key shape series making 3-in. wide rings.
3. Ribbed construction gives more stability and rigidity to the roof. Four rings of 12-in. brick form the valleys, and two rings of 15-in. brick form the ribs.
4. Lateral plates in the roof brickwork provide an inexpensive but adequate suspension media. The plates are a necessity to maintain the roof contour between hold-down beams. Plates $\frac{3}{16}$-in. thick are installed in the center of the valleys and in the center of the ribs entirely across the furnace width.
5. The brickwork in the roof is bonded so that the continuity of longitudinal brick joints is broken. Bonding of the brickwork plus the steel plates prevent longitudinal cracks from forming in the arch. Alternate rings are started with $4\frac{1}{2}$ and 3-in. brick on the skew to produce the bond.
6. Provision for longitudinal expansion is unnecessary, and jacking of the roof brickwork to assure tight-

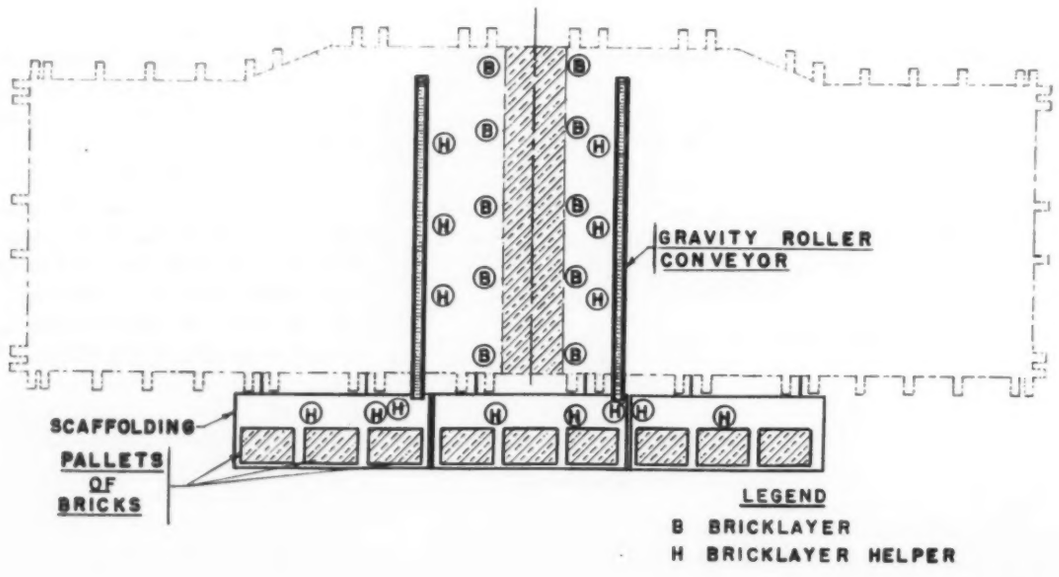


Figure 5 — Scaffolding hung on the furnace simplifies the roof construction procedure.

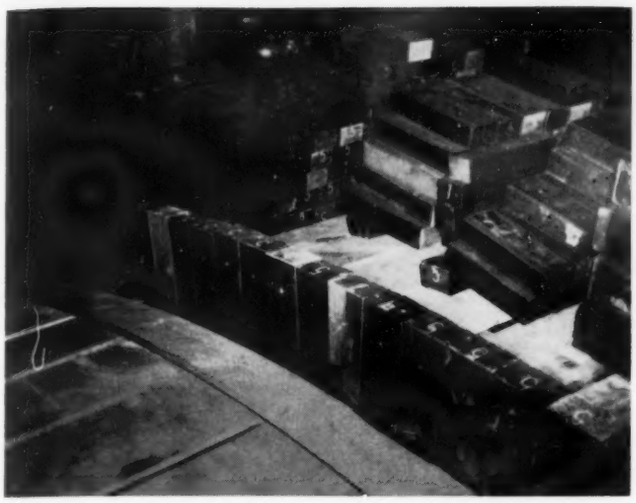


Figure 6 — A wooden strip is nailed on the roof centerline to provide a starting point.

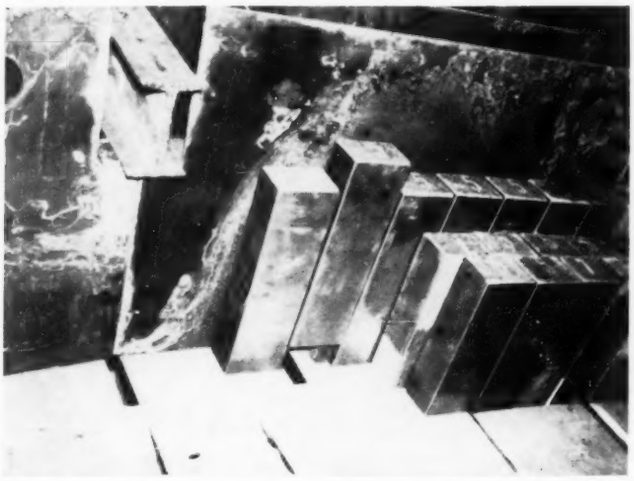


Figure 7 — Alternate rings are started with 4½ and 3-in. brick on the skew to remove continuity of longitudinal brick joints.

ness may be beneficial.

7. Lateral expansion is provided at the hot end of the brick only by inserting a tab of asbestos paper $\frac{1}{16}$-in. thick and 3-in. wide every two brick for five ft from each skew and every four brick of the crown of the arch.

8. The roof cannot be permitted to rise on heat-up as is done with silica roofs. The roof must be held down rigidly before fuel is put on the furnace. Seven longitudinal rows of 6-in. I-beams uniformly spaced across the arch and extending the entire length of the main roof are used to perform this function. At six locations from end to end of the roof, pipes are securely attached to the beams and are pinned tight against a furnace structure cross member.

9. The roof should be kept as free of dust and dirt as possible to prevent disintegration of the plates, especially over the three center doors where patching occurs.

Figure 5 is a plan view of the furnace during the installation of the roof showing the placement of equipment, materials and workmen. The scaffold is hung on the furnace binding at the elevation of the top of the front skew channels. The pellets of brick are placed on the scaffold by fork lift truck. Individual brick are conveyed across the roof by gravity rollers. The bricklayers and helpers take positions approximately as indicated.

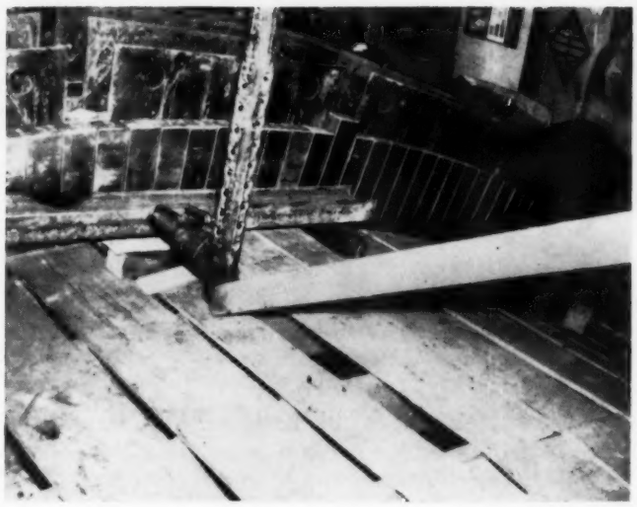


Figure 8 — The roof is tightened by jacking toward the furnace center after each 11 ft of roof has been completed.

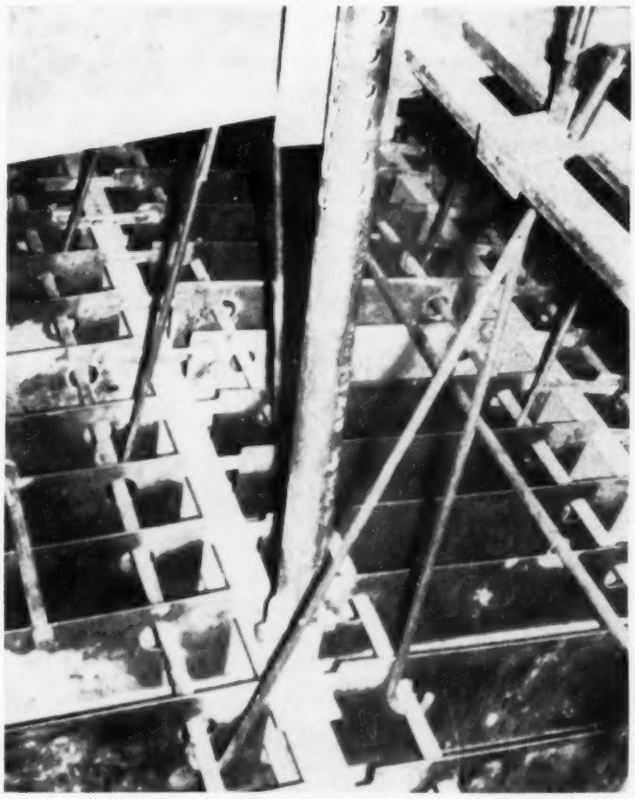


Figure 9 — Typical construction features are the I-beam hold-down, the adjustable pipe legs and the J-shaped bolts.

The roof is started at the centerline and brickwork proceeds toward each end of the furnace. In starting the roof a 1-in. piece of lumber is carefully nailed on the roof center to assure a true working point, as shown in Figure 6. When three rings of brick have been installed, the board is removed and brickwork is started on the other half of the roof.

Figure 7 displays several details of the erection work. Plates have been installed between the 15-in. rings of the rib. Two 12-in. rings of the valley have been started, and mid-valley plates will be placed next. The asbestos

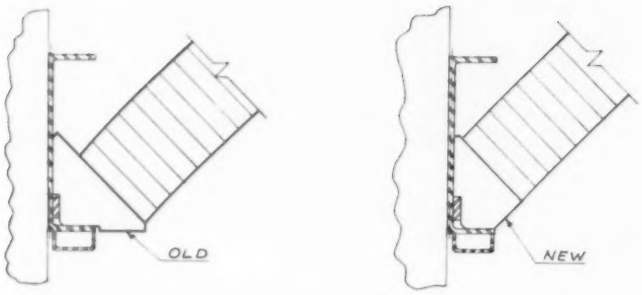


Figure 10 — Redesign of the skew back brick has eliminated a roof deterioration problem.

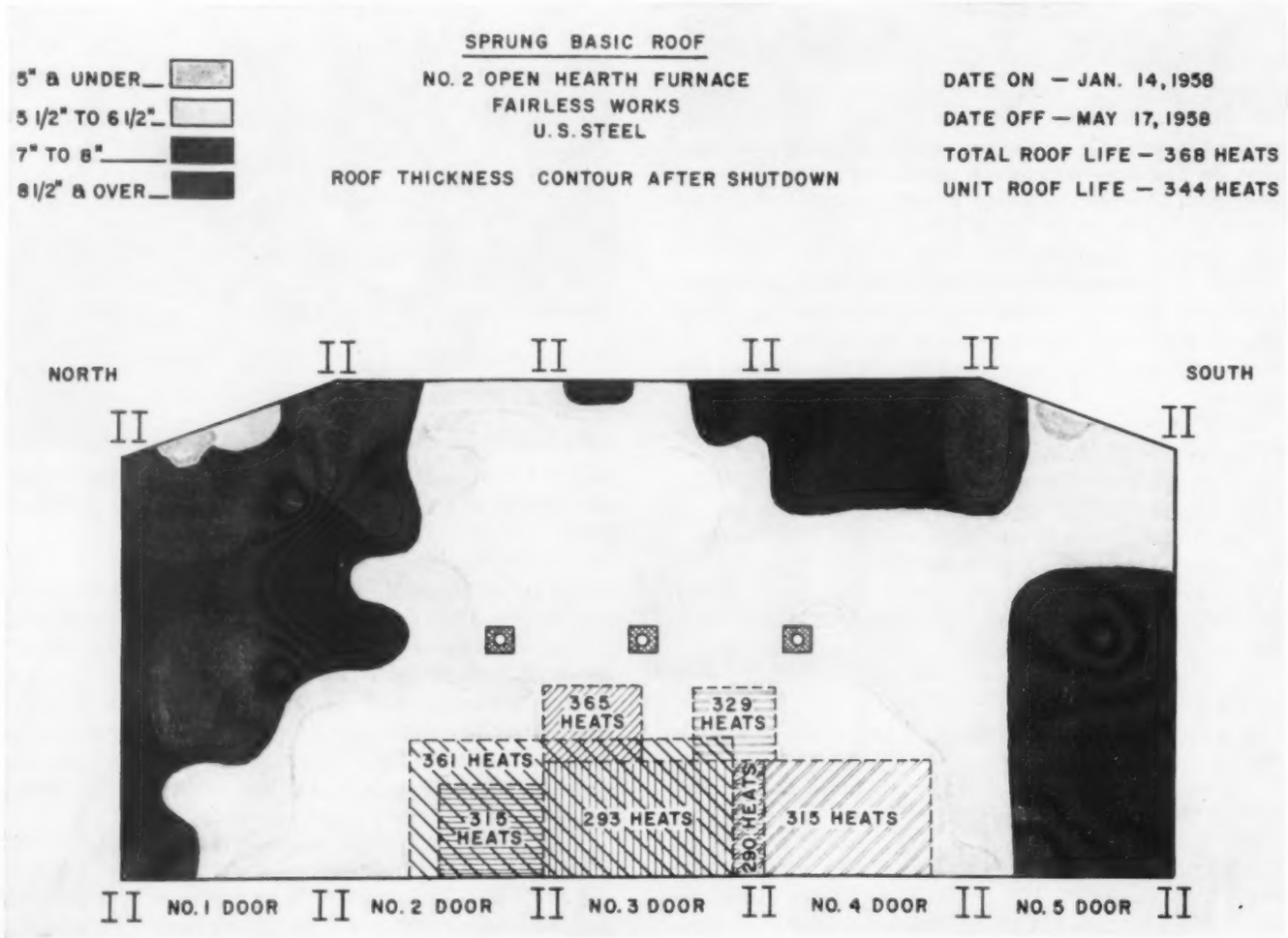
Figure 11 — Suspension plates and hold-down beams must be used in hot patching a basic roof.

expansion tab is evident in the 12-in. ring. One of the three keys to be driven in place across the arch has been provided. To assure maximum strength in the hold-down system the plates butt beneath a hold-down beam and the beams are joined beneath a hold-down pipe.

To assure tightness the roof is jacked toward the center of the furnace after each 11 ft of brickwork has been installed. (Skew channel sections are 11-ft long.) Jacks are used in pairs at four points across the roof as illustrated in Figure 8. The resulting looseness longitudinally is generally $\frac{1}{8}$-in. per ft or less. Tightness may be an important factor in over-all roof life; however, successful roof campaigns have been completed in the industry on roofs which were not jacked.

Figure 9 is a typical section of the top of the furnace showing the plate construction, the hold-down beam and the plates spliced together over the top of the beam to tie the brickwork and suspension steelwork together. The adjustable pipe leg is fixed in place to hold the beam and the roof down as well as up. A pipe for blowing graphite from the roof may be seen on top of the plates at the left of the picture. Seven 1-in. pipes are installed across the arch of the roof and extend longi-

Figure 12 — The first roof campaign wear pattern has proved to be similar to succeeding wear patterns.



tudinally for the length of the roof, and ⅛-in. holes every nine in. in the pipe provide the jet stream for blowing the graphite from the roof. The compressed air control valves for blowing the roof are operated at floor level. Also shown are 1¼-in. bars inserted through the roof plates which are held to the overhead furnace structure by J-shaped bolts to provide additional suspension strength. Some roofs have been constructed without suspension bars and J bolts to determine their value.

Observations on early furnace roofs disclosed that the shape of the front skew brick may have been contributing to the deterioration along the front four to eight ft of the roof. In Figure 10 the view at the left illustrates the old skew brick which overhangs the skew channel by seven in. It appeared that the overhanging section sheared off early in the campaign and that the shearing action progressed up the roof. A redesigned skew brick has been installed and experience to date has indicated that the new skew has virtually eliminated the excessive roof deterioration in the immediate front skew area.

Basic roofs require some hot patching and this is accomplished successfully in a manner similar to that used in patching silica roofs. It is essential that suspension plates be installed in the patched area and that the hold-down beams be maintained to prevent the patch from losing contour. Thorough grouting of the new brickwork with a thick chrome ore slurry helps to secure the patch. In Figure 11 the new plates have been installed in the hole to be patched. These plates are engaged over and under the hold-down beam similar to the original construction, and 1¼-in. steel bars are inserted through holes in the lower part of the plate to support the prebent steel sheeting that is used as a form on which to lay the brick. Generally 9-in. basic patch brick have been used in hot patching. No expansion strips are used in the patch and one key is driven in each ring for every four ft of ring length.

The results of roof thickness measurements taken when the first knuckle-to-knuckle roof campaign was completed are displayed in Figure 12. Since that time the wear pattern on most roofs has been found to be similar. Hot patching is required between No. 2 and No. 4 doors along the front portion of the roof rather than across the back as was experienced with silica roofs.

Pertinent data on fifteen completed basic roof furnace campaigns include the following results: all heats were produced with 420 to 520 cu ft of roof lance oxygen per ton of ingots. The average heat size was 345 tons. Average roof life for the 15 campaigns was 401 heats. The roofs of the three furnaces were sprayed on the hot face in the critical areas with an air-setting chrome slurry during the latter part of their campaigns. This treatment proved beneficial in reducing the amount of patching required and in extending the life of the roofs. The difference in roof life between the two halves of the roof of No. 3 furnace indicates the failure of that portion employing 63 per cent MgO brick in which a natural magnesite containing a relatively high iron content were used. This half roof was replaced with silica brick to complete the furnace campaign. The different MgO contents of the brick used are indicative of trials made to determine the composition of the best refractory for basic roof construction. Additional trials are in progress but no definite conclusion has been reached.

In summary, the sprung basic roof has made a most valuable contribution to improved open hearth operation and productivity. The average roof life of the basic roof is more than twice the life of silica roofs. The cost of this type of basic roof exceeds the cost of the previously used silica roof by 80 per cent. It is apparent from these figures that the roof cost per ton of ingots is decreased measurably by the use of basic roofs. Increased operating rates, decreased total outage time for rebuilds and reduced lost time for hot patching further enhance the value of the sprung basic roof.

Discussion

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E. Eldrett: Some of the basic roof patches followed each other quite closely. What was the criterion at time of patching and what was the thickness patched against?

J. Hannigan: Could increased roof life have been more cheaply accomplished with patching by daily gunning or spraying?

K. D. Bartels: Figure 9 was shown to illustrate the wear pattern and not necessarily to typify patching heat for heat. Some of the patches were close together. In patching a basic roof, it is felt that there should be five or six in. of brickwork to key against. However, that cannot be judged as with the silica roofs, because in later stages of the campaign it is hard telling how far you would go to find the actual roof thickness. The first patch, or any patch, occurs once the roof is broken through, and the hole is of such a size that it is believed that it is economical to patch rather than to merely plug. The size of the patch is determined by the contour of the brickwork surrounding the patch. Often the dirt accumulation on the roof has become excessive to the point that the suspension plates oxidize and the brickwork begins to sag. That area is taken out and replaced.

There are no comparative cost figures available with regard to gunning, which is not done without cost. During "forced draft" production periods, the downtime on the patching may spell the difference between patching and gunning. Gunning is almost a constant affair after a roof gets along in the campaign; an attempt is made to keep the area darkened so that it does not break through. Patching and gunning are related, but at this point the cost basis is not clear enough to indicate which method should be used.

DESIGN AND OPERATION OF OPEN HEARTH PRECIPITATORS WITH OXYGEN LANCES

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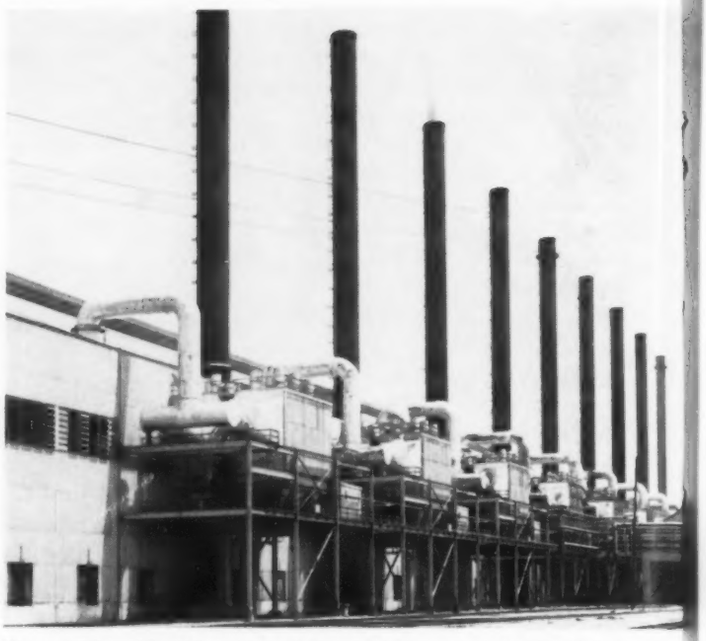


Figure 13 — Modification of the dry type precipitators has substantially reduced air pollution.

THE concern of civic groups toward air pollution has increased in recent years and in many cases governing bodies have enacted legislation to control air pollution. United States Steel Corp., among others, has accepted its responsibility to improve conditions. Operations that emit smoke and fumes are a subject of experimentation and research, the goal being to eventually control these emissions to practical and reasonable limits, see Figure 13. One approach to the problem in the open hearth at Fairless works has been the installation of dry type precipitators on each furnace. Installation and operation of this equipment is very expensive and this is the reason for a search for a better way of reducing excess smoke at a reasonable cost.

The use of oxygen roof lances, higher firing rates and larger heat sizes have contributed to the dust problem. The increased production and decreased heat time made the original precipitator installation inadequate.

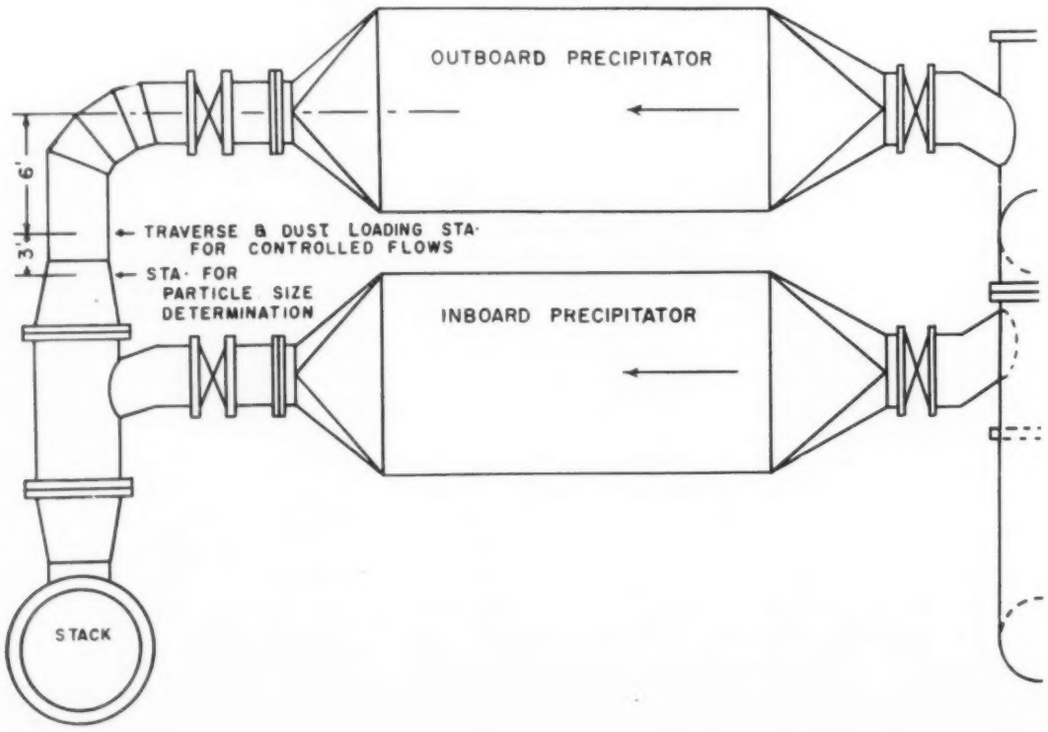
The original installation was powered by electrostatic mechanical rectifiers without automatic power regulation. This system worked very well in confining limits, that is, the output voltage had to be held down so that when the gases became heavily laden with dust the units did not trip off. This meant that when the dust loading was light the units were not operating at peak voltages. They were operating at less than maximum efficiency for existing conditions. Electronic rectification with automatic power regulation has provided a solution to this problem.

With mechanical rectification and furnaces operating without oxygen lances approximately three tons of dust per furnace per 24 hr was collected. With electronic rectification and furnaces operating with oxygen lances the dust collected is approximately five tons per furnace per 24 hr. A detailed study revealed that a greater power input was necessary to maintain high efficiency.

The precipitators were originally designed for the following conditions:

1. To operate in series with and after the waste

Figure 14 — Two precipitators acting in parallel clean the flue gas from each furnace.



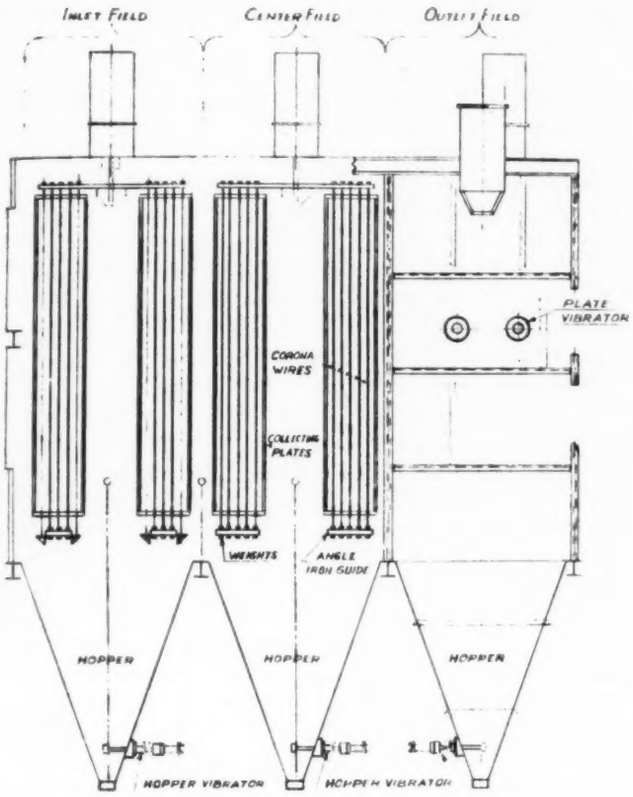


Figure 15 — The gas flow must pass through three magnetic field sections in the precipitator.

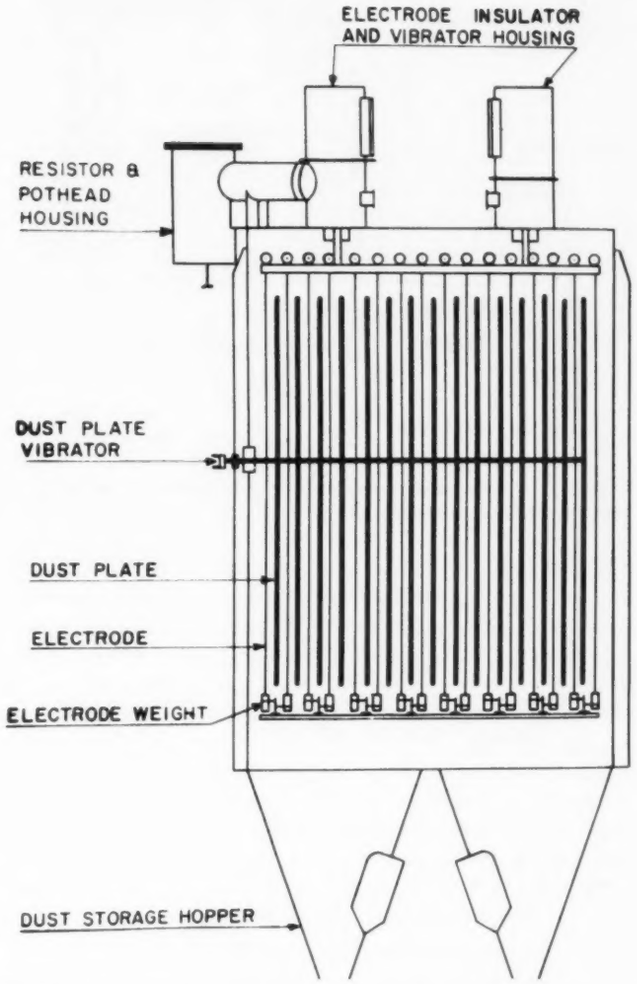


Figure 16 — Vibrators shake dust from the plates and wires periodically to maintain precipitator efficiency.

heat boilers and to clean a total flue gas volume of 75,000 cfm at 575 F with a minimum dewpoint of approximately 116 F. Two precipitators are installed per furnace to operate in parallel.

2. The flue gas pressure at the precipitator inlet to be within the range of 1-in. water column above and below atmospheric pressure.

3. The draft loss through the precipitators not to exceed 0.25-in. water column.

The precipitators are installed after the waste heat boiler, see Figure 14. There are two precipitators per furnace and they can be operated independently or in parallel. Normal operation is in parallel. With this arrangement either unit may be shut down for necessary repairs. Each precipitator is fed by a 4 ft-6-in. diameter duct which is a take-off from a 6-ft rectangular area 22-ft high by 14-ft wide with a vertical perforated plate installed at a right angle to straighten the gas flow. Pressure relief disks are installed in the outlet transition member. The disks are stainless steel, 0.018-in. thick and of 47.5-in. diameter. The disks will pop out at about 2-oz pressure, which protects the precipitators from damage.

The precipitator (Figure 15) has three chambers, an inlet, center and outlet field which are 22-ft high, 14-ft wide and 10 ft-6-in. long. Each chamber (Figure 16) or field has 36 plates 3 ft-6-in. wide, 17 ft-5-in. high (spaced on 10-in. centers) hung in line with the gas flow. Centered between the plates five wires are hung on 6-in. centers with a total of 162 wires per field. The plates are grounded to the structure at the upper end. Midway down the assembly a vibrator is attached for cleaning. This assembly is rapped every 30 sec.

The wire assembly (Figure 17) is supported on two quartz insulators with a 14-in. OD 2 ft-3 1/2-in. high and of 3/4-in. minimum wall thickness. This assembly has vibrators in the spring suspension hangers which are rapped for 20 sec every ten min. The air supply to the vibrators was 90 psi. Observation showed that this pressure was causing wire breakage and arc-over. Pressure reducers were installed to reduce the pressure to 65 psi.

Porcelain insulators are now being tried in place of the quartz because porcelain is about one half the price of quartz. In addition the highly glazed surface does not permit dust to build up as rapidly and porcelain does not tend to crack as readily as quartz when flash-over occurs. Some concern as to whether porcelain would hold up under the high temperature is one of the reasons for the slow progress of change over. However, with 108 high tension insulators in service and an average consumption of about six per year this problem is not of major importance. All evidence to date indicates that porcelain insulators in the presence of the 550 F temperature will hold up and give satisfactory life.

The electrode wires (corona wires) are 19 ft-2-in. long barbed wire. Inlet field corona wires have barbs on 2 1/2-in. centers, while the center field and the outlet field have barbs on 5-in. centers. Each wire has a 16-lb weight attached to its lower end to maintain the wire tension. All weights are hung in angle iron weight guides which prevents swinging and subsequent grounding.

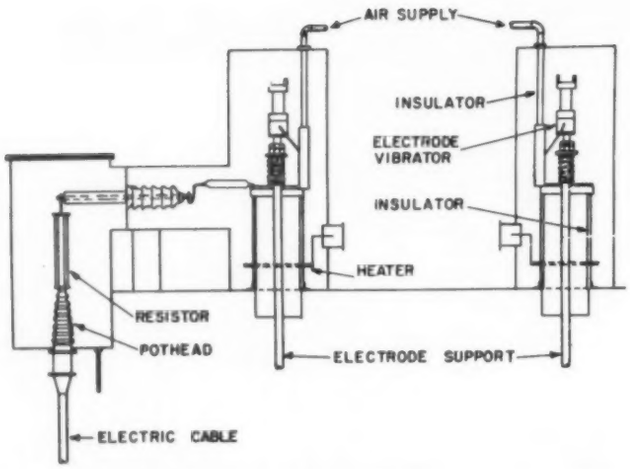


Figure 17 — Porcelain insulators are being tried in the 550 F ambient temperature.

The precise alinement and clearance of the plates and wires is of utmost importance since variations will cause shorts at high voltages thereby limiting the power input. The use of barbed wire electrodes instead of the original square electrode wire has permitted higher electrical input and more efficient dust collecting.

The original installation had three 30-kva power units per furnace without automatic power regulation. These were arranged in the following order: one per field, that is one power unit for the inlet field, one power unit for the center field and one power unit for the outlet field, see Figure 18. The modification to electronic rectification has resulted in:

One 30-kva power unit for the inlet field.
One 40-kva power unit for the center field.
Two 30-kva power units for the outlet field.

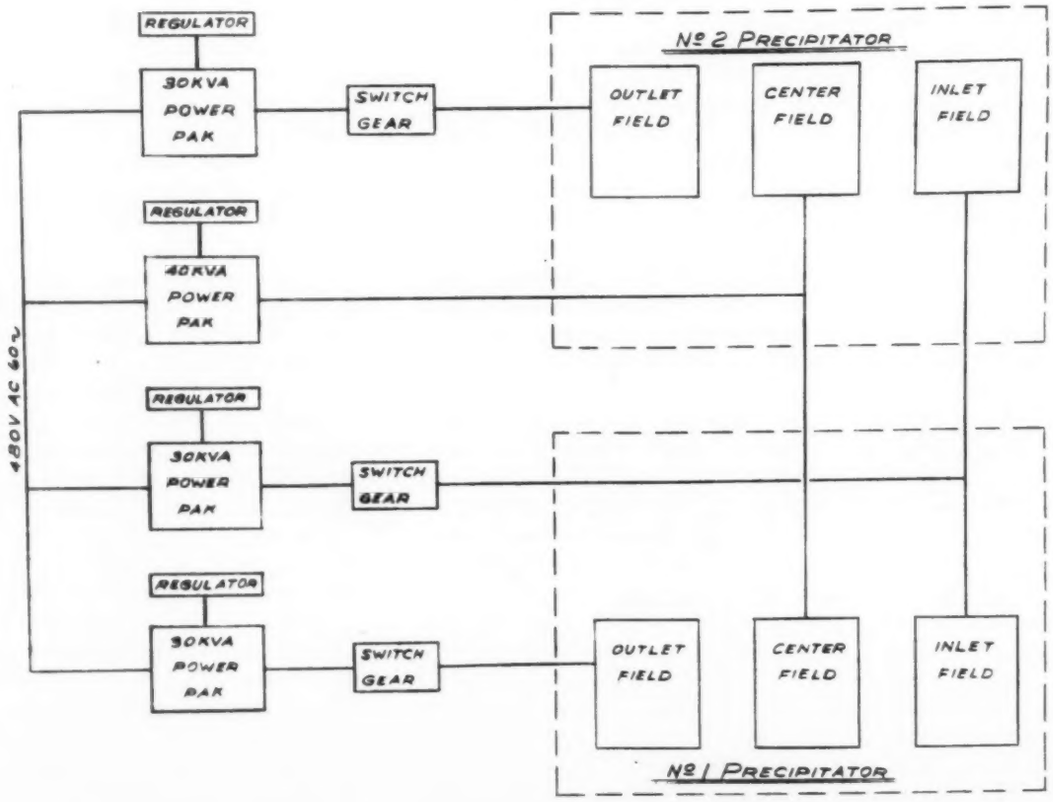
Each unit has automatic power regulation which permits maximum power input without indiscriminate tripping.

The initial settings of the power units are 225 to 250-volt input with input current held to about 35 amp. This produces approximately 40 milli-amp output. After approximately three hr the input voltage is raised to about 300 volts and the input current is raised to 50 amp which results in an output current of about 65 milli-amp. The final adjustment of the voltage and current is accomplished by increasing the voltage until the output current milliammeter begins to oscillate rapidly. Experience has shown that this is the best setting for continuous operation.

The main transformer has a ratio of 150 to 1 which is 440-volt input to 65,000-volt output. With this power source corona discharge is at its best. For optimum dust collection the precipitator should be operated at a point just below arc-over. At this point the corona discharge will ionize the maximum number of particles. The particles are both negatively and positively charged; however, most of the particles are negatively charged and are attracted to the positively charged collector plates. The positively charged particles are attracted to the negatively charged corona wires and are deposited. If the corona wires were not vibrated this deposit would insulate the corona wire and ionization would be greatly reduced. Automatic voltage regulation maintains the maximum voltage for the prevailing conditions at all times. At the present time the frequency of trip off is at a minimum. The increased voltage and the fact that the optimum voltage condition exists most of the time accounts for the increased dust collection. The optimum voltage condition is about 100 spark overs per min.

Automatic voltage regulation is accomplished as follows: a saturable reactor (Figure 19) is installed with the main winding connected in series with the

Figure 18 — Installation of automatic power regulation allows constant operation at optimum voltage conditions.



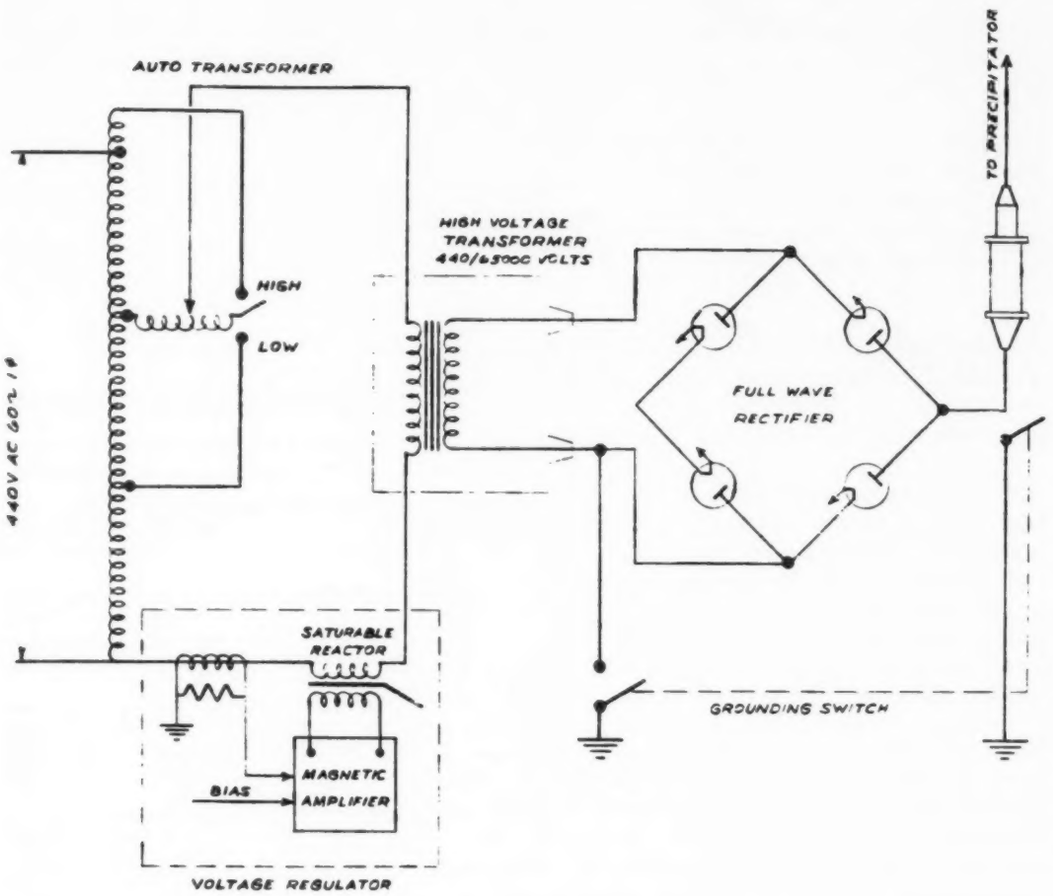


Figure 19 — The use of a saturable reactor in the main winding of the transformer allows use of the highest voltage possible for any gas condition.

primary transformer winding, and the saturating winding is energized by the electronic control. The impedance is affected by the amount of d-c excitation. A reduction in impedance permits higher voltages while an increase in impedance lowers the voltage. The electronic control performs two separate functions. One section works continuously to reduce the impedance while the other section increases the impedance by a predetermined amount each time the precipitator sparks over. If gas conditions change so that there is less frequent spark over the voltage will rise until spark over occurs. Then the control will

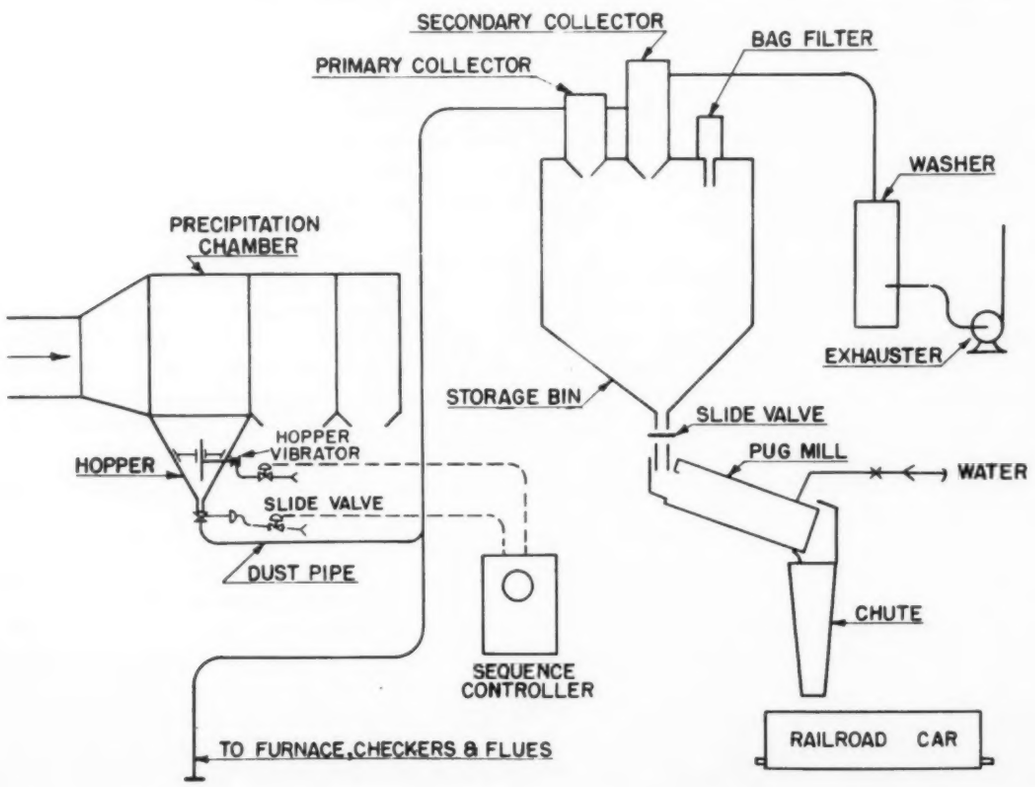


Figure 20 — A vacuum system draws the dust from the individual precipitators into a large hopper.

counteract the rate of rise thereby maintaining the voltage at a value which permits moderate spark over and consequently the highest voltage possible for the given conditions.

Each power unit is connected to an audible alarm which will sound when the unit trips off. In addition indicating lights have been installed in the central dust collecting station so that the operator is aware that a unit has tripped off. This is necessary because of the distance from the dust control room to the respective power unit rooms.

The dust collecting system is automatic to the extent that after the vacuum system is started and the respective furnace selector switch is pulled, the system will advance from valve to valve as each hopper and furnace is cleaned.

The vacuum system (Figure 20) is powered by two 100-hp units. Each motor drives a positive displacement rotary vacuum pump. The vacuum pumps are located between No. 5 and 6 furnaces and the piping is split into two sections for the shop. Each furnace has an (air operated) segregating slide valve. When this valve is actuated the vacuum is directed to the respective hopper slide valve which is then opened automatically. At each hopper valve there are two air admittance valves which permit air to enter to convey the dust. While dust is being moved the vacuum remains high, but as the hopper empties the vacuum will drop. The drop in vacuum actuates a mercury pressure switch which in turn starts a continuous vibrator, this usually dislodges more dust and the vacuum will rise turning off the vibrator. This sequence continues until a low vacuum is held for 20 sec and only then will the system advance to the next valve and close the preceding valve. Each precipitator has 12 dust hoppers. The dust is drawn through the 6-in. main header to the primary dust cyclone and then to the secondary cyclone. The air is then passed through a water washer and finally to the rotary vacuum pumps. Both the primary and secondary cyclones drop the collected dust to the main hopper which is equipped with a 12-in. slide gate. Air jets and vibrators are installed to facilitate dust movement. The dust is fed to a horizontal pug mill which is equipped with water sprays. The quantity of water is manually controlled so that the dust and water is discharged as a loose mud. This is dropped into a railway gondola car for disposal.

The dust vacuum system is not without problems because any moisture in the pipe lines will cause plugging which makes the system inoperative. These plugs must be removed manually.

In colder weather precautions must be taken to heat the dust line by drawing hot gases from an open hopper so that when the dust is passed through the line the dewpoint of the gases is not reached. If this is not done, plugging will occur readily. The dewpoint is approximately 116 F.

The multitude of air valves, air cylinders and air-operated slide valves present many problems. For instance all rappers operate continuously imposing a severe cycle on the solenoid valves. These valves are being converted to a diaphragm type instead of the original poppet type. Initially lubrication was critical on air cylinders and vibrators; however, new style cylinders which require no lubrication have been operating very well. The dust handling and collection systems will continue to be improved to provide lower maintenance costs.

Thus, experience in this shop can be summarized in two statements:

1. Open hearth gases can be effectively cleaned with electrostatic precipitators.
2. The modifications made to the Fairless works open hearth precipitators has restored them to the original 98 per cent efficiency.

Discussion

PRESENTED BY

JOHN W. LEMING, JR., Assistant Fuel Engineer, Bethlehem Steel Co., Bethlehem, Pa.

JACK TRENNER, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Bethlehem, Pa.

A. T. PARADIS, General Foreman, Assigned Maintenance, Open Hearth Div., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

H. W. DORSET, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

J. W. Leming, Jr.: Has anyone found a use for the material that is taken out of the precipitator? A divisional superintendent once asked why the collected dust which was cleaned out of the waste heat boilers was not sent to the sintering plant. That was tried some years ago. The sintering plant personnel do not seem to want it.

A. T. Paradis: Some of the collected dust can be used in the sintering plant.

J. Trenner: Is the wire used in the precipitators a standard steel barbed wire with a normal galvanized coating, or is it a special wire purchased for this purpose?

A. T. Paradis: The ionizing wires are standard steel barbed wire with special spacing of the barbs.

H. W. Dorset: We have had some trouble collecting dust, particularly from the sintering plant hoppers. It sticks in the hopper even though there are vibrators on the bins. A suction system is being used at Fairless works dumping the dust into a storage bin, and then the dust is passed through a type of pug mill, with the addition of water. Do you have any trouble with freezing in the winter time because of this water mix?

A. T. Paradis: The water mix has not made freezing in the cars a problem.

H. W. Dorset: What is the capacity of one precipitator? Evidently one of the units is shutdown for maintenance and the other is kept going. How does the efficiency or over-all capacity of the one unit compare with the total of the two, when operating in parallel? There must be some limitation.

A. T. Paradis: The capacity of one unit is one half of the two parallel precipitators. When only one unit is in service the efficiency is decreased. ▲

Full-Time Radiation Program Protects Bethlehem's Personnel

GUARDING against the harmful effects of radiation from industrial sources is a full-time activity at Bethlehem Steel Co.

The use of X-ray machines, radium and radioisotopes for the examination and inspection of materials, the determination of liquid densities, the measurement of bin and tank content, the control of rolling mill operations and for many other purposes has brought about a full-time protection program covering all personnel working with radioactive material or in radiation areas.

Bethlehem has been engaged in radiation control activities ever since it purchased and used its first radiation machine. These random activities became an official program in 1948 with the publication of a booklet entitled "Regulations Governing Nonmedical Uses of X Rays and Radium."

Ten years later, a radiation control engineer was acquired to be responsible for radiation control programming throughout the company's operations, and one of his first actions was to update the 1948 booklet, which now bears the title, "Regulations Governing Nonmedical Uses of Ionizing Radiation."

POLICY

All supervisory personnel responsible for handling sources of radiation must be sure that employees under their control have the proper training to observe safe procedures at all times. The supervisor also must make certain that each man wears an appropriate monitoring device, and knows the whereabouts of radioactive material in the department. The supervisor also strictly enforces established regulations; confers with the radiation officer regarding radiation hazards in his area; sees that outside contractors use radiation equipment under approved conditions; and makes sure that each worker involved undergoes medical examinations and blood tests, as required.

At first the main uses of radiation were to determine if weldments had been satisfactorily made, if there were foreign materials in castings and in other types of nondestructive testing.

RADIATION SOURCES

However, a new type of X-ray unit in the form of a thickness measuring gage was introduced in 1948 at the Sparrows Point plant to give a continuing record of the thickness of steel rolled on the sheet and strip mill. Use of these gages were extended to other applications, i.e., these gages also control interface locations on plated materials.

One of the early requirements for control of radium and X-ray sources was that all X-ray and radium surveys were to be made by qualified experts who were not employees of Bethlehem Steel Co. The rapid increase in the use of gaging devices (there are now 49 at Sparrows Point alone) and the application of similar units to other operations of the company made it impossible for the survey requirements to be met by an outside, independent expert.

Consequently, it became necessary to employ a radiation control engineer in the industrial health engineering department who could conduct this and other related phases of an all-inclusive program.

FILM BADGE PROGRAM

All personnel who may be exposed to significant industrial radiation hazards are enrolled in film badge program. An occupational history of each individual is kept on file by the industrial health engineering department and his radiation exposures as measured by the film badge are recorded.

The badge is a small rectangular plastic container holding one beta-gamma packet and one neutron film.

The badge also contains three filters: a 0.079-in. thick lucite filter, a 0.039-in. piece cadmium filter and 0.197-in. copper filter. The type of radiation to which the wearer has been exposed and its effective energy can be determined by the use of these filters.

To determine beta-gamma radiation, a special commercial film packet is used containing a sensitive and an insensitive film. When a density of a known amount is reached on the sensitive film, a detectable amount is seen on the

insensitive film. All these films are sequentially numbered by the manufacturer so that records of exposure can be maintained.

After development, these films are evaluated by means of transmission density measurements. The technique consists of "zeroing in" the control film on a densitometer from a particular facility. Densities indicated on the film which are higher than the zeroed value indicate exposure. By this technique, 5 millirems of X-ray or 15 millirems of gamma radiation can be detected. The interpreted films are permanently filed. Neutron exposures are evaluated by microscopic counting of neutron tracks on the exposed film badges. About 30 millirems of neutron dose can be detected by this technique.

UNIQUE LABORATORY

Bethlehem maintains its own film processing laboratory to provide internal control of film developing techniques and instrument calibration.

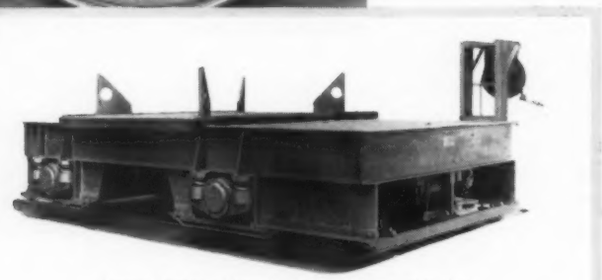
The laboratory is also responsible for the registration and licensing of all radioisotopes used and other sources of ionizing radiation as required by various government agencies.

In addition to the film badge program, the radiation control activities include a leak-testing program for sealed sources such as radium and isotopes, with appropriate records kept in a permanent file. The AEC requires that a leak test on sealed isotopes be made at least every six months. Field surveys of all radiation sources are also conducted periodically. New or modified installations receive special attention.

Common sources of industrial radiation are:

1. Metal radiography (X-rays of various energies and gamma rays from radioactive materials, such as radium, cobalt, iridium and cesium).
2. Metal thickness gages (X-rays of various energies and beta radiation from such sources as strontium).
3. Devices to measure liquid densities (mostly gamma rays from cesium).
4. Devices to measure liquid and solids levels in tanks and bins (mostly gamma rays from cesium).
5. Electrostatic eliminators (radium, polonium and other alpha emitting materials).
6. Tracer studies and quality control (various types and amounts of radioactive material, depending on the use).
7. X-ray and electron diffraction and electron microscope type of equipment.
8. Electron tubes operated at voltages above 15 kv and those which contain radioisotopes to aid in their performance.

The rigidity of Bethlehem's regulations concerning the handling and guarding of radioactive materials and the strict rules governing the activity of personnel involved with these materials are necessary safeguards, the observance of which is a must for all concerned. ▲



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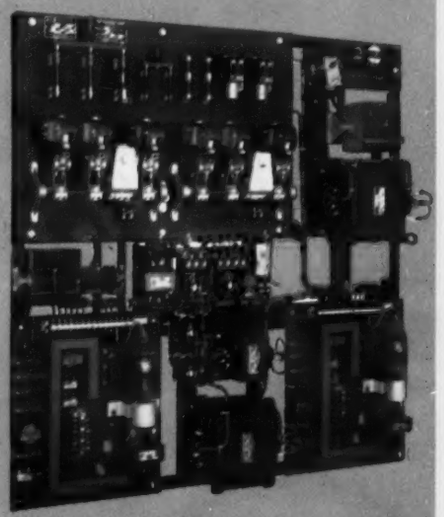

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Arthur G. McKee & Co. Signs Coke-Oven Licensing Agreement

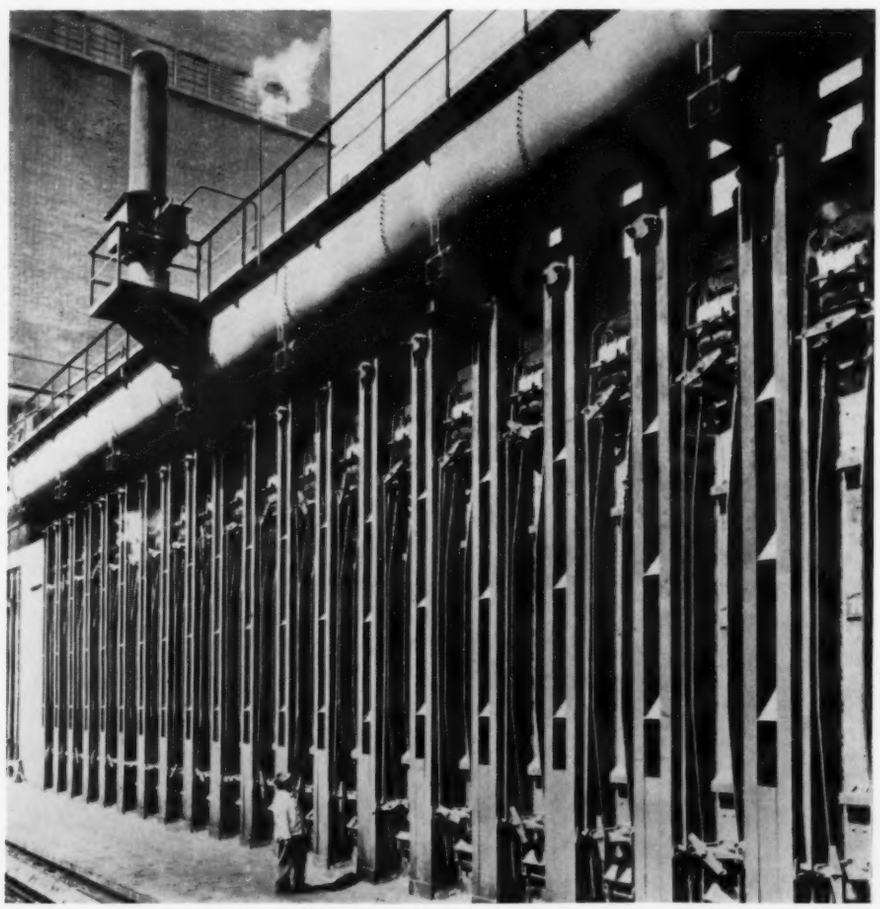
THE completion of a licensing agreement will permit Arthur G. McKee & Co. to introduce on the North American Continent coke ovens of the type built by Firma Carl Still, Recklinghausen, West Germany.

The Still-designed coke ovens have characteristics that give them important economic and operational advantages over the kinds of ovens now in general use on this side of the Atlantic.

Key to this design is its multi-stage heating system which permits the construction and operation of ovens up to 20 ft in height compared with those of 10 to 14 ft in height generally in current use in this country. Multi-stage heating is achieved through the combustion of fuel gas at a number of different levels in the heating flues, whereas combustion in conventional ovens operated in this country takes place only in the lower part of the oven. This multi-stage combustion results in a uniform heating of the taller ovens, assuring a differential temperature of considerably less than 54 F from bottom to top of the 20-ft oven walls.

These ovens are of the gas-gun type using a half-wall reversal heating arrangement with a conventional horizontal flue on top, and are designed for rich-gas and lean-gas underfiring. In coke-oven gas underfiring, the gas is fed into gun flues located in the upper part of the walls between the regenerators from which the gas enters the heating flues through predetermined size nozzles. The air for combustion passes from the sole or bus flues into the bottom of the regenerators, and after preheating, enters the heating flues at the various levels. The partition walls between these flues are provided with slots at five or six levels over approximately 75 per cent of the flue heights, and combustion takes place over almost the entire height of the flue. When heating with a rich gas such as coke-oven gas, all of the partition walls between the flues supply combustion air. For lean-gas heating, alternate partition walls supply gas and air. This method of heating assures that the coal charge is homogeneously and evenly coked.

Figure 1 — Multi-stage heating permits economic operation of 20-ft high coke ovens.

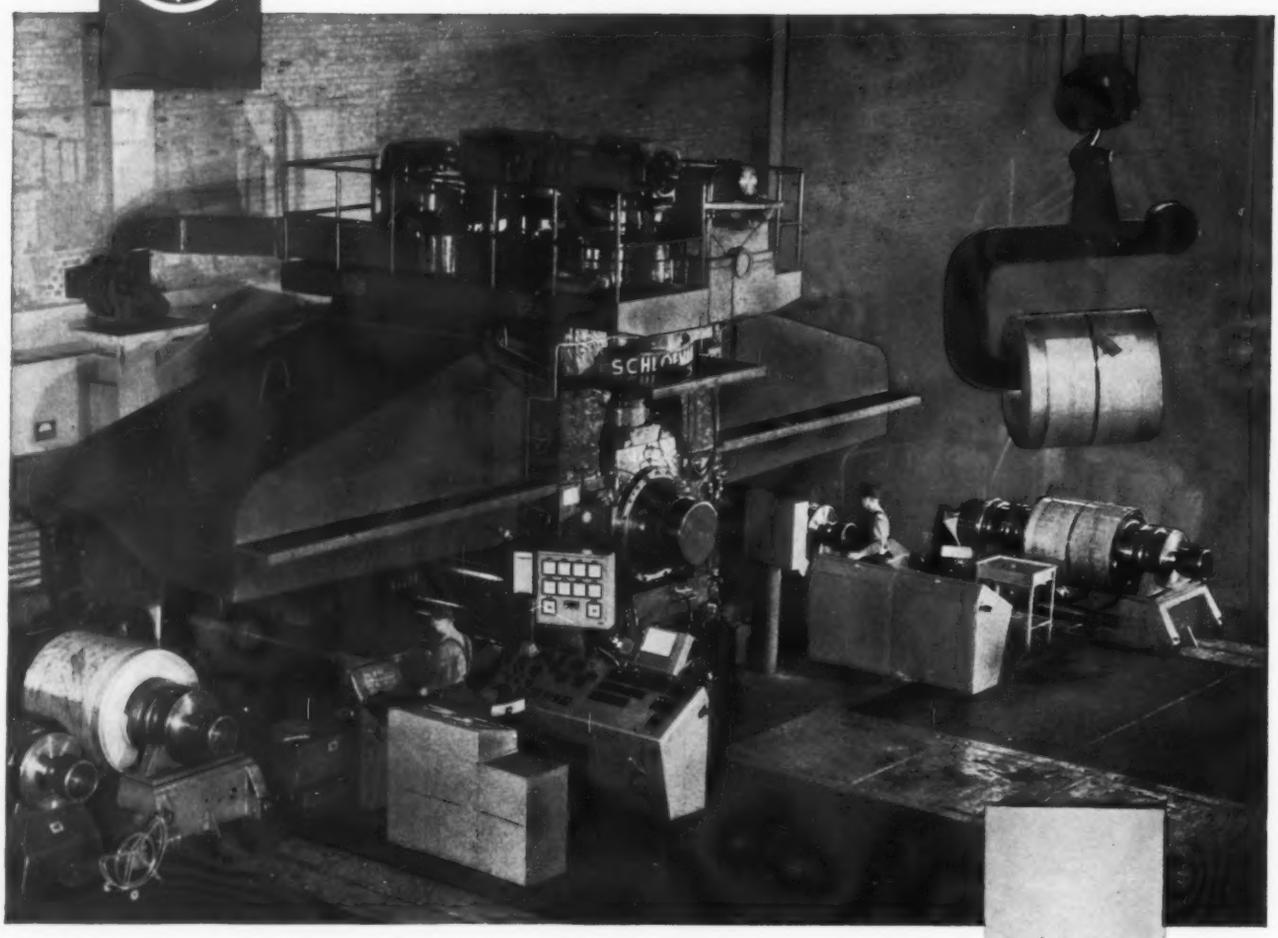


These ovens have an average width of about 18 in., a height of about 20 ft, a length between buckstays ranging from 44 to 50 ft, a center-to-center of ovens of about 4 ft-5 in., and an effective volume in excess of 1150 cu ft. This oven capacity is about 60 per cent over the capacity of a 13-ft oven. Coal throughput is about 36 per cent higher per unit of battery length and the ovens occupy about 30 per cent less area for the same coking capacity.

Coke production per man with the high oven is about 60 per cent greater than that of the 13-ft oven. The importance of the saving in manpower is illustrated by the following figures: for a plant with 13-ft ovens and a throughput of 3000 tons of dry coal per 24 hr, an average battery force of 64 men per day is required for the oven operations whereas for a plant equipped with 20-ft ovens, 40 men per day are required for the same carbonizing capacity.

There are 288, 20-ft ovens of the Still design being operated currently in three coke plants in West Germany. The first battery of high ovens was built in 1927 and, of those now in operation, 192 were originally constructed in the period between 1927 and 1938 and the remaining 96 between 1952 and 1956. Now being readied for operation at the newly constructed Zollverein coke plant of Gelsenkirchen Bergwerks AG near Essen are 96 additional 20-ft ovens while an extension of this plant is under way, which will add 96 more of the same high ovens. ▲

SCHLOEMANN

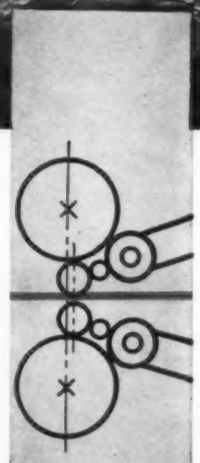


MKW mill rolling alloy steel strip 50 in. wide in a Swedish steel plant

MKW in Sweden

For the past three years an MKW mill in Sweden has rolled wide alloy steel strip. MKW rolling mills in Europe, North and South America today produce many thousands of tons of high-grade steel and non-ferrous strip every year. MKW mill stand designs are patent-protected. Constructed on simple lines they are thoroughly dependable. As small-diameter work rolls are used at high speed, large pass reductions and close tolerances are obtained.

MKW rolling mills can be equipped with four types of roll set-up (two-high, four-high, MKW and double MKW), and as a result their range of application is correspondingly expanded.



MKW roll set-up

FELLER ENGINEERING COMPANY 1161 Empire Building, Pittsburgh 22, Pa.

HOT AND COLD ROLLING MILLS • COUNTERBLOW HAMMERS • HYDRAULIC PRESSES

Litho-Strip Corp. Installs New Continuous Coating Line

UP to 1,000,000 sq ft of steel coil per day is processed by a new continuous strip metal coating line put into operation recently at the Chicago plant of Litho-Strip Corp. This $1,250,000 line is believed to have greater capacity than any other in existence, whether its output is measured by weight, width of strip, or surface area.

In a continuous cycle, aluminum and cold-rolled and galvanized steel, fed into the line at one end, are chemically cleaned and surface treated, painted, cured, cooled and rolled up into coils for shipment to order. Coating may be applied to one or both sides in one pass, in any combination of colors and hundreds of patterns available in epoxy, vinyl, acrylic or alkyd finishes. Widths are run up to 68 in., gages up to 0.064 inch. Tolerance of coating thickness may be controlled to plus or minus 0.0001 in. of standard.

Optimum operating speed is 150 fpm, and at this rate, the machine will finish 9000 ft of 24-gage, 60-in. wide strip per hr, a total of 45,000 lb of steel.

Although designed primarily to handle wide material, the line will also handle narrow widths and light gages where matching finishes are required.

Over-all length of the line is 367 ft, from centerline to centerline of payoff and recoil reels. The curing oven is 120-ft long. Accumulator towers at either end of the line are 40-ft high and displace the accumulator rolls through a vertical distance of 27 ft while the line continues in operation.

Coils of up to 20,000 lb are unloaded from a coil car and placed on either of two uncoilers, which without accessory fixtures, are adjustable to fit coils with 16 to 20-in. cores. Fittings are attached to accommodate cores from 20 to 24 in. in diameter.

Successive coils are joined together continuously to form an endless strip of metal. While the strip is held temporarily in place for joining, the four rolls in the elevator mechanism of the entry accumulator ordinarily operated in the raised position are lowered to release accumulated strip to the line. This permits continuous operation while the coils are being joined.

When the joining operation has been completed, the uncoiler feeds out metal at an accelerated rate and the elevator is retracted to the raised position until the slack metal reserve has been reaccumulated. The accumulator reserves enough strip to feed the treatment and painting stations for more than one min with the line operating at maximum speed.

The line is powered by six main

Figure 1 — Emerging from the oven, the work is passed through the cold water spray unit, center, then onto the second accumulator, at right. Squeegee rollers just beyond the spray unit remove excess water. Evaporation from the warm metal makes it bone dry by the time it reaches the accumulator.

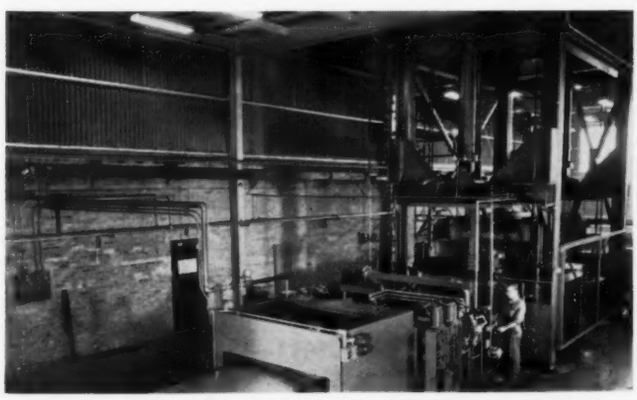
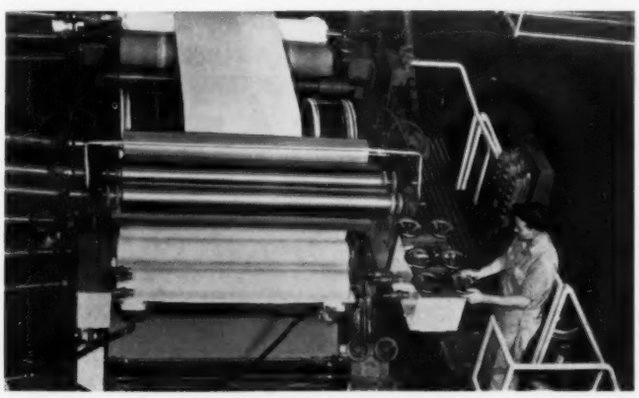


Figure 2 — Both sides of the strip may be coated in one pass, using either the same or different colors.



drive motors synchronized in a Ward Leonard system and has a total of 565 connected hp. Some drive motors are of a regenerative type and are capable of either pulling or holding back, as conditions require.

From the accumulator, the stock is fed into the chemical cleaning and treatment tanks, where it passes through a 5-stage cycle: alkali cleaning, hot water rinse, chemical surface treatment, cold water rinse and chromic acid passivation bath. Steel is phosphatized, and aluminum is given a chromate treatment, to protect the surface against corrosion and to provide better adhesion for the paint coat.

The treated strip is next drawn across the first roll coater, where paint is applied to the top surface. A recirculating paint system is used in conjunction with the coater in order to maintain accurate viscosity control. Two heads are provided, so that quick color changes, as well as special printed patterns, may be run.

The under side is coated at the next following station by a similar process. The two sides of a strip segment may be coated with the same or different paints without recourse to any mechanical adjustment.

The coated metal is then run through the gas-fired oven, where it is baked at high temperature. The strip is then cooled by a cold water spray, air dried and passes to the recoiler through an exit accumulator.

The exit accumulator, normally in the lowered position, stretches the travel distance by extending when metal is being sheared at the end of the line. Accommodation for slack metal is the same, duplicating the action of the entry accumulator, allowing more than one min for the strip to be sheared and for the leading edge to be hooked into a recoiler.

Metal may be treated and coated in specified widths or slit to order following the treatment and painting cycles.

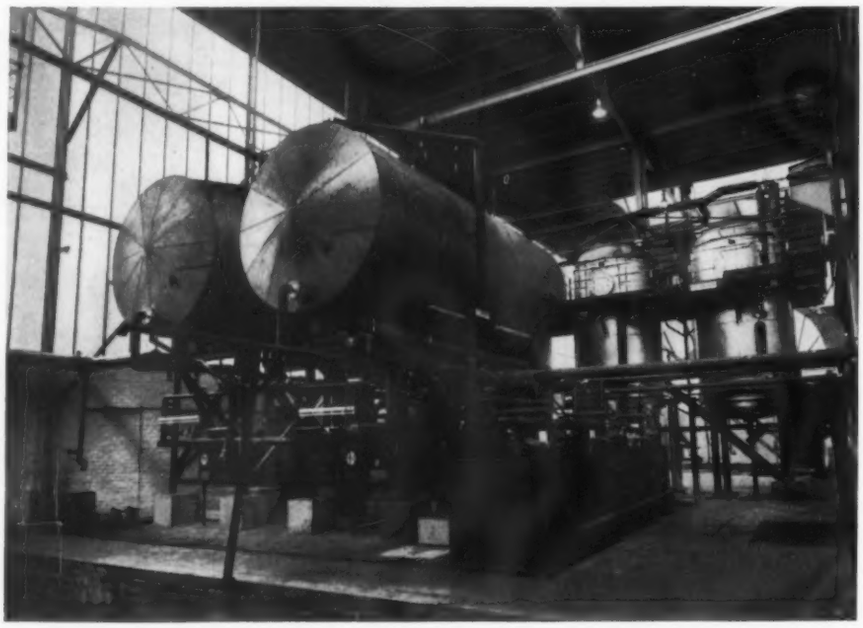
Stainless steel pumps are used to circulate solutions in the treatment tanks. Phosphate and chromate solutions are periodically subjected to chemical analysis and restored to standard strength.

When no metal stock is threaded through the line, a stringer is towed through and left standing until operations are resumed, when the stringer is used to thread the initial metal stock into the machine at startup.

The installation is set on foundations running six ft into the ground. The floor slab is a minimum 30-in. thick, and there are top and bottom reinforcing grids of $\frac{3}{4}$-in. rods. About 800 yd of concrete was poured into the foundation.

The entire line, including drainage and venting, was engineered to Litho-Strip Corp. specifications. Installation was part of an extensive expansion which added 54,000 sq ft of plant. Three smaller lines run parallel to the new line. The plant also houses paint storage facilities for 50,000 gal, research and development and control laboratories, warehouse facilities and office space. ▲

For Complete Rolling Mill Oil Recovery and Water Clarification Consult TITZEL



TITZEL has the "know-how" and the engineering experience to do all or any part of your clarification projects. Titzel designs and installs the Complete System.

Shown above is a Titzel Cold Mill Palm Oil Recovery System which enables repeated reuse. A Phone Call to MUseum 1-9622 brings complete information.

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Since 1928 **TITZEL ENGINEERING, INC.**
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ALLIED COMPANY, TITZEL ENGINEERING & EQUIPMENT CO.

Photo courtesy Inland Steel Company

control destructive water hammer with HUNT DESCALING VALVES

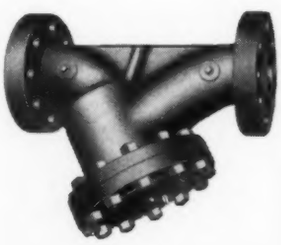
In daily service in a majority of the hot strip mills throughout the world, Hunt accumulator shut-off and descaling valves provide years of dependable, trouble-free service.

Designed to reduce hydraulic shock and excessive maintenance, Hunt valves feature special porting and long piston travel . . . they open and close gradually, reducing water hammer in the system to an absolute minimum.

Dead shut-off conserves pump capacity . . . maintains full flow to working headers. Opening and closing speeds are easily controlled . . . pressure-balanced packing and corrosion-resistant materials assure long life. And, when maintenance finally is required, valves may be repacked in place. Ruggedly built of electric furnace cast steel, Hunt valves withstand highest working pressures and inherent system shock with ease.

Widely used also for hydrostatic testing, Hunt valves are available for pressures up to 2500 psi, in sizes from 2 through 8 in., separately or as part of a complete descaling system, including a completely automatic Hunt-built accumulator control panel.

Put Hunt's years of experience to work for you. Call your Hunt representative for recommendations while your system is still in the design stage. Or, write for more information, requesting Bulletin 517. Address Hunt Valve Company, Salem, Ohio, Dept. ISE-661.



HUNT HIGH PRESSURE STRAINERS remove scale and other impurities . . . prevent nozzle clogging with resultant strip reject for scale streaks . . . protect valves. Built to withstand 1500 psi pressure differential . . . easily maintained. 2 through 8 in. sizes.

3017

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

Argon Teeming of Degassed Steel

A METHOD of making quality alloy steel by vacuum degassing molten steel in the ladle, developed about two years ago by A. Finkl & Sons Co., which removes gases, making the steel cleaner, tougher and more ductile, has been improved. Two steelmaking refinements have been added to the vacuum degassing process and the pouring of aircraft quality alloy steels.

One of these refinements is a method of pouring vacuum degassed steel through a blanket of argon gas and into ingot molds filled with argon which was originally developed by the Linde Co. Development Laboratory. This method keeps oxygen in the outside air from reaching the molten steel after it has been degassed.

This is done by attaching a steel collar about 15 in. in diameter around the pouring outlet in the bottom of the ladle holding 75,000 lb of vacuum degassed steel. Attached to this collar is an argon feeding hose from the tanks of compressed argon.

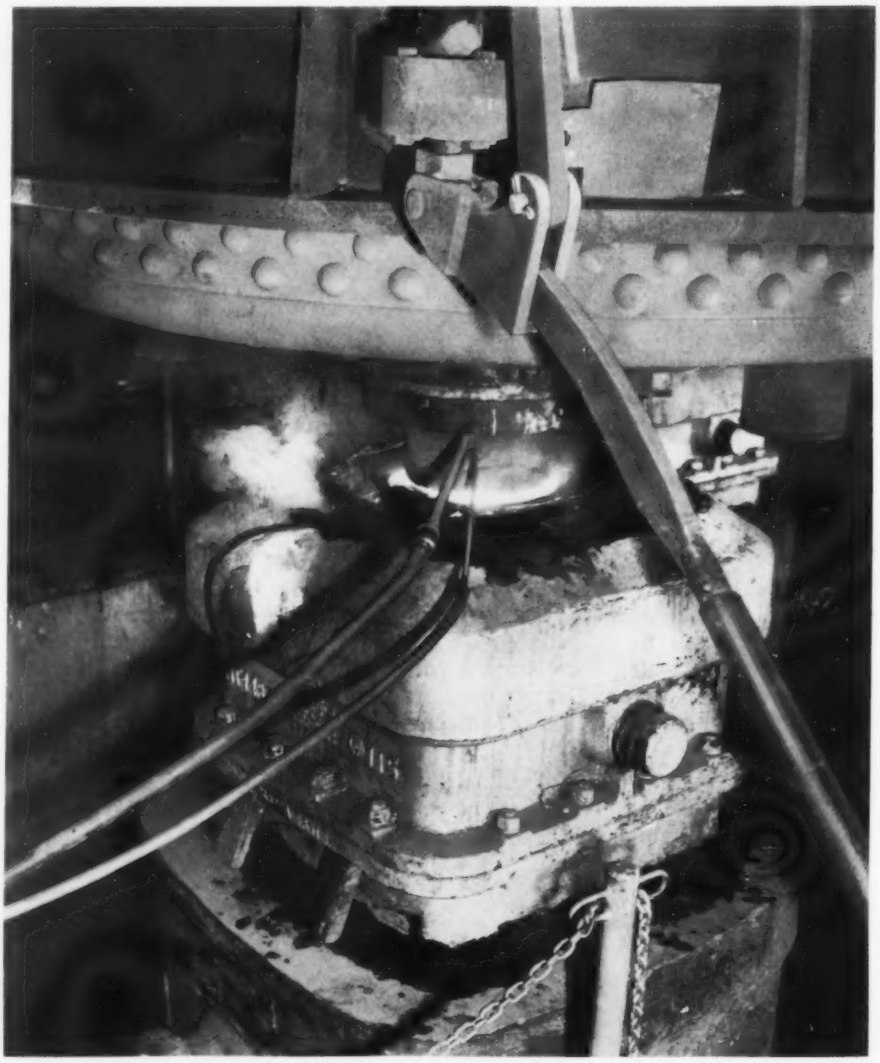
The ladle is then lowered to within an in. from the top of the ingot mold, which has previously been filled and sealed with argon gas. Then the argon gas is turned on filling the collar with the inert gas, the stopper rod is opened and the steel is poured through this blanket of argon gas.

The practice is to argon fill the molds in teeming order and to complete filling the last mold before teeming the first ingot. This practice is feasible because eight or fewer ingots are teemed per heat.

The air in each mold is displaced by lowering a 5-in. diameter by 10-in. long diffuser to the bottom of the mold and filling the mold with argon. Using 3000 cfhr of argon, a 23-in. ingot mold for an 8000-lb ingot is filled in 30 sec.

A Leeds & Northrup oxygen analyzer, recalibrated for argon with analyzed mixture, is used to check the residual oxygen. When checked with a sampling tube at the top of the ingot body, under the prescribed filling conditions, the residual oxygen is always below 0.5

Figure 1 — The steel is teemed through an argon gas shield into the ingot mold which has been prefilled with argon gas.



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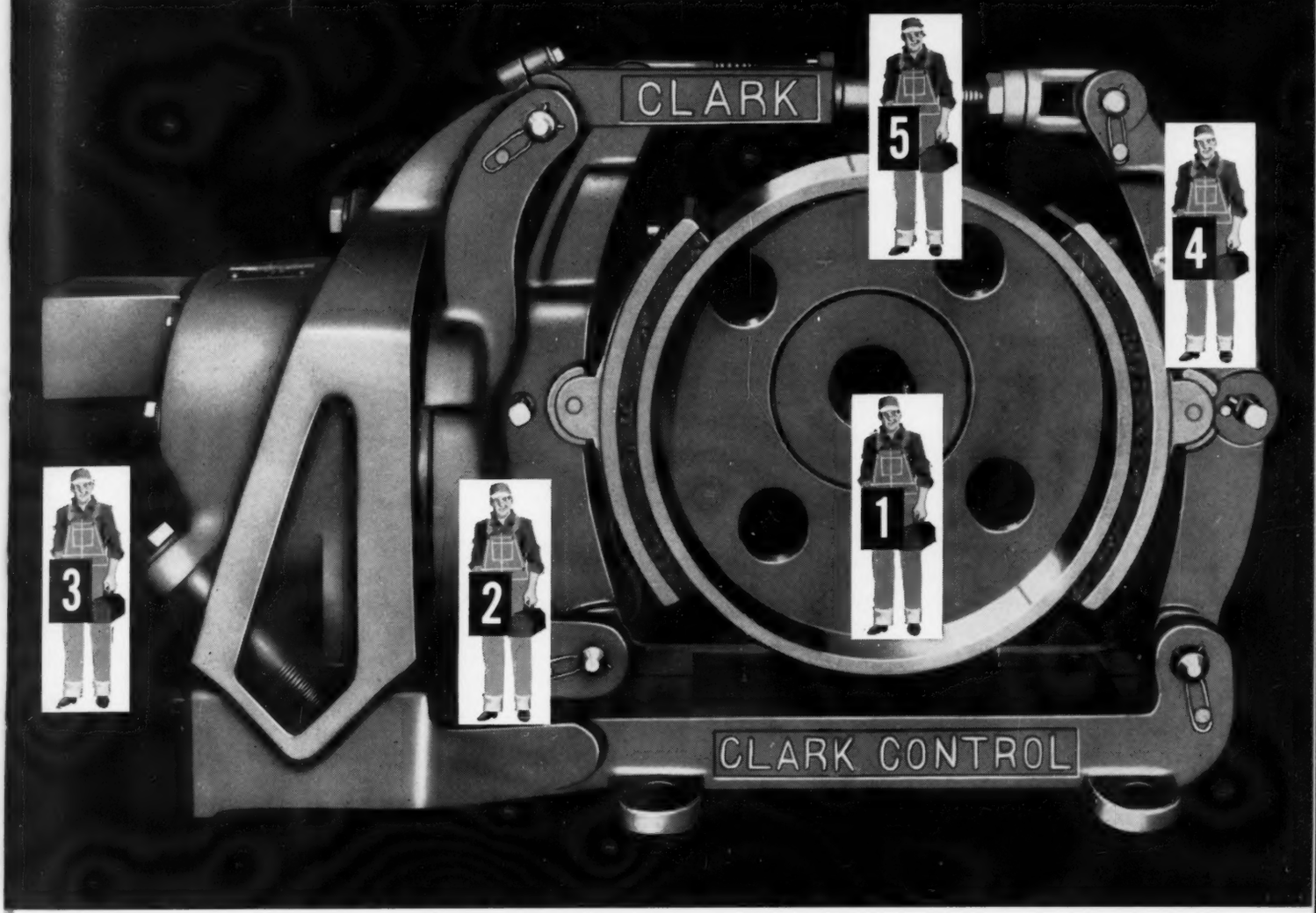

Here's how Clark design helps

Any brake works properly when new. Clark brakes are easy to keep working that way.

It's the brake troubles that occur *after* thousands of operations that Clark engineers had in mind when they designed the AISE-NEMA D-C Magnetic Brake line.

Hundreds of successful applications attest to the design superiority that has made these brakes the choice of maintenance men wherever service conditions are most rugged.

Clark maintenance-reducing features include:

1 Powerful "nut-cracker" principle of operation, with shoe-arms hinged at top, assures equalized pressure on both shoes, improves lining life.

2 Top-hinging of magnet armature puts widest part of magnet air gap at bottom, so most of the dirt falls free—minimizing stoppages.

3 Magnet case and coil replaceable on the job without affecting brake adjustment or releasing brake. Self-contained, epoxy-potted coil is quickly and easily replaced in the case.

4 Interchangeable self-aligning shoes are readily replaceable and fit either side, either end up.

5 Maintenance adjustment is on *top* of brake for easy access.

PLUS many other Clark "maintenance-saver" features that greatly reduce downtime, speed maintenance, simplify adjustments and replacement of wearing parts.

For complete details on Clark D-C magnetic brakes, request a copy of Bulletin 106-B from your nearest Clark Controller sales office. Or write to : 60MB1

THE CLARK CONTROLLER COMPANY

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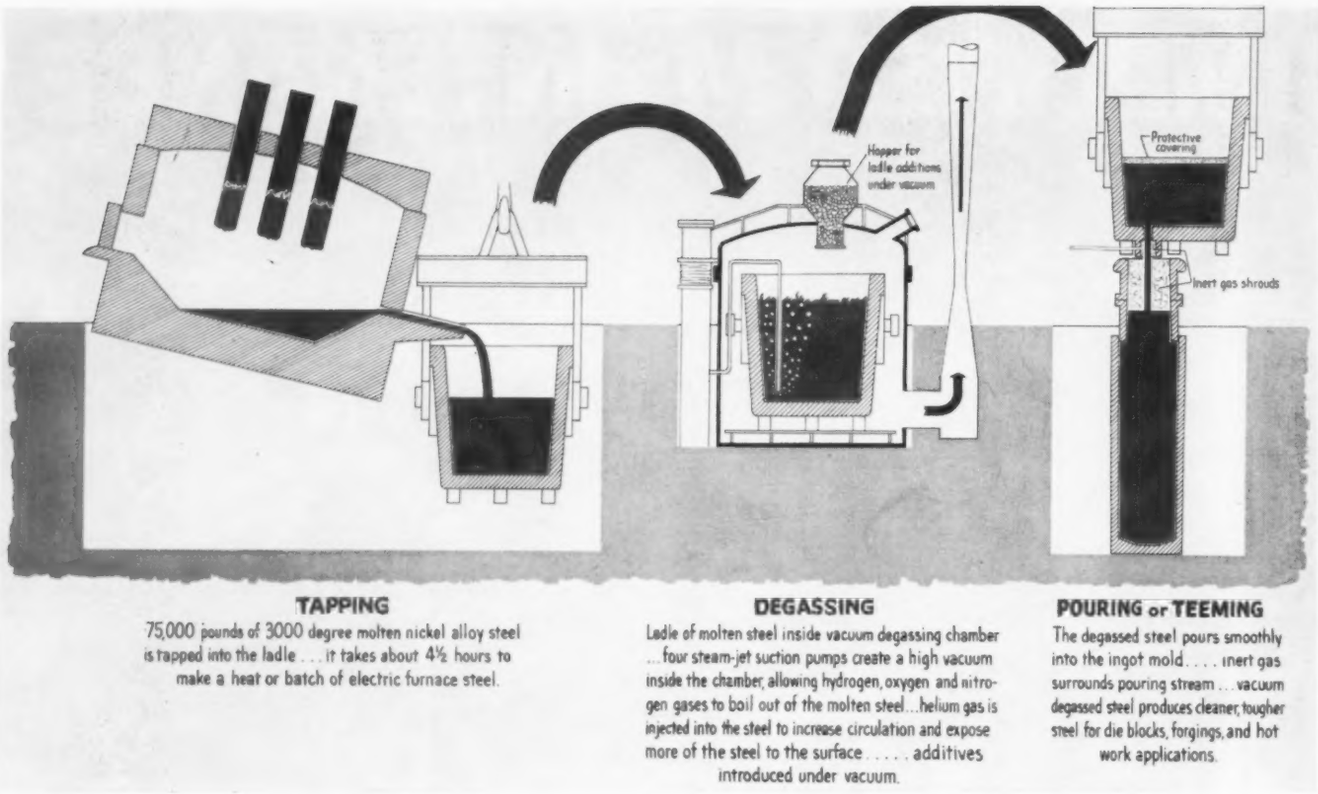
Hopper for ladle additions under vacuum
Protective covering
Inert gas shrouds
TAPPING
75,000 pounds of 3000 degree molten nickel alloy steel is tapped into the ladle . . . it takes about 4½ hours to make a heat or batch of electric furnace steel.
DEGASSING
Ladle of molten steel inside vacuum degassing chamber . . . four steam-jet suction pumps create a high vacuum inside the chamber, allowing hydrogen, oxygen and nitrogen gases to boil out of the molten steel . . . helium gas is injected into the steel to increase circulation and expose more of the steel to the surface . . . . . additives introduced under vacuum.
POURING or TEEMING
The degassed steel pours smoothly into the ingot mold . . . . inert gas surrounds pouring stream . . . vacuum degassed steel produces cleaner, tougher steel for die blocks, forgings, and hot work applications.

Figure 2 — The schematic drawing illustrates the vacuum degassing process used and the refinements added.

per cent and approaches zero. A well sealed mold will maintain less than 1 per cent of oxygen until teemed.

The teem stream protector is attached to the bottom of the ladle during teeming. An argon shroud is provided by a header with radial holes directed at the stream. The oxygen analyzer provides a continuous analysis of the argon surrounding the stream. By starting an 1800-cfhr flow of argon ten sec before each nozzle opening and reducing the flow to 800 cfhr during teeming, the oxygen surrounding the stream is kept below one per cent.

Argon consumption averages 20-cu ft per ingot ton with a range of 18 to 22. This high argon consumption results from the low average teeming rate of 1⅓ tons per min.

The other refinement in Finkl's practice is the development of a method to put additives in the molten steel while the ladle of steel is under a high vacuum inside the degassing chamber.

This has been accomplished by installing an air tight hopper in the top of the large degassing chamber. Limestone, aluminum and other additives are placed in the hopper before the vacuum degassing process starts, sealed tight, and then released during the process.

The addition of these materials at this particular time in the cycle contributes to improving the quality of the steel and serves as an insulating cover over the molten steel during the pouring period.

Tests were with 40-in. ingots, two per heat, each weighing 17.5 tons. Two heats were used. On the first heat, the first ingot was air teemed and the second ingot argon teemed. The order was reversed on the second heat.

Gas samples were cored from the surface, mid-point, and center locations of blocks forged at mid-height of all four ingots. The average gas contents are given below with a probability statement that the difference is due to chance.

Teemed in	No. of analyses	Gas, ppm H	O	N
Argon	12	1.5	31	26
Air	12	1.7	40	37
Probability		0.01	0.2	0.001

These results definitely show a gas pickup during teeming in air and indicate that it would be of concern in critical applications. ▲

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

How grid tray life was increased from 4 to 72 months

Electro-Alloys' knowledge of thermal fatigue extends service life 1700%

Figure 1 shows a grid tray used to move a solid cube of steel through a heat-treat furnace where side burners directed flame over the top of the tray, Figure 2. After 3-5 months' service, this tray would distort and fail, Figure 3. A photographic close-up of the failure is shown in Figure 4.

The user assumed the failure was due to inadequate pushing strength. With strengthened pushing ribs, the redesigned tray lasted only 2-3 months, half as long as the original design.

In view of this behavior, the user requested an Electro-Alloys design evaluation. The results are shown in Figure 5. *This new tray has a service life of 5-7 years!*

Pinpointing cause of thermal-fatigue failure

Electro-Alloys found that the *original tray* had been *overdesigned.* Extensive knowledge of the subtleties of thermal fatigue led to this conclusion.

Study of the furnace operation showed that the zones of heating and a heavy cooling concentration were the real causes of tray failure. They acted in this way:

On entry into the furnace, outside members of the tray heated more rapidly than inside members. As a result, expansion of these outside members was restricted by the cooler inside members. This set the stage for compression failure of outside members.

Farther in the furnace, inside members came up to temperature. But outside members had already forged in and were undersized. Now, expanding inside members subjected outside members to tensile stresses. This double reversal of stresses, compression then tension, during every cycle soon produced failure.

Any attempt to strengthen these outside members results in earlier failure because the increased mass leads to the metal fighting itself even more.

New design solves problem

The new design, Figure 5, called for raising the transverse ribs. This allowed the heated air to pass under the heavy die block. Through this simple change, it was possible to bring the die block to temperature more quickly and to eliminate the high temperature differential between outside and inside members of the tray.

The result is a 1700% increase in service from each tray.

Avoiding expensive thermal-fatigue pitfalls

Users and designers of heat-resistant castings are vulnerable, generally, to two pitfalls that lead to losses in service life and operating economy:

a. Assuming that an alloy operating well at 2000°F. will work just as well in a different application whose maximum temperature is only 1700°F.

b. Too much faith in the calculation of applied stresses as the measure of the casting's ability to withstand service conditions. This is reflected by increasing the size or number of restricting members . . . braces, gussets and tie rods.

These pitfalls are a natural outgrowth of the lack of information on thermal fatigue . . . the cause of 90% of all failures of heat-resistant castings.

Electro-Alloys is recognized as the leading authority on thermal fatigue and high-alloy casting design. Hundreds of case histories — such as the one reported here — and the widely published test data emanating from the Research Laboratory at Mahwah, N. J., are evidence of this.

● *Most recent of these reports is "The Mechanism of Thermal Fatigue," by H. S. Avery. Copies of this study are available on request. Simply write to Electro-Alloys Division, 3036 Taylor Rd., Elyria, Ohio.*

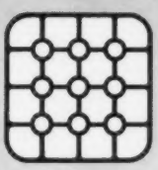


FIG. 1

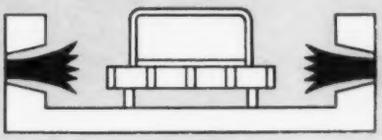


FIG. 2

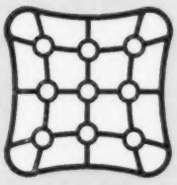


FIG. 3

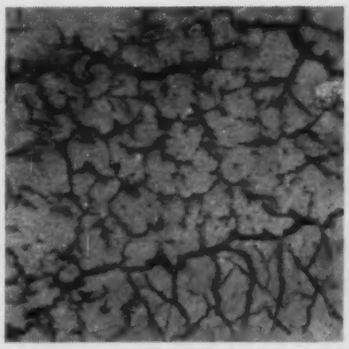


FIG. 4

FIG. 5

AMERICAN Brake Shoe COMPANY ELECTRO-ALLOYS DIVISION • Elyria, Ohio

Owner: **Western Hotels, Inc.**
Electrical Engineer: **Mr. Fritz Klawa,** Portland, Ore.
Electrical Contractor: **Pitman Electric Co.,** Portland, Ore.

Electrical Protection is MODERNIZED with BUSS Fuses in the Multnomah Hotel, Portland, Ore.

In this well-known hotel of the Northwest, it became necessary to modernize the electrical system to take full advantage of the many uses for electricity today.

BUSS Hi-Cap and FUSETRON dual-element fuses were installed to assure safe, dependable and lasting protection.

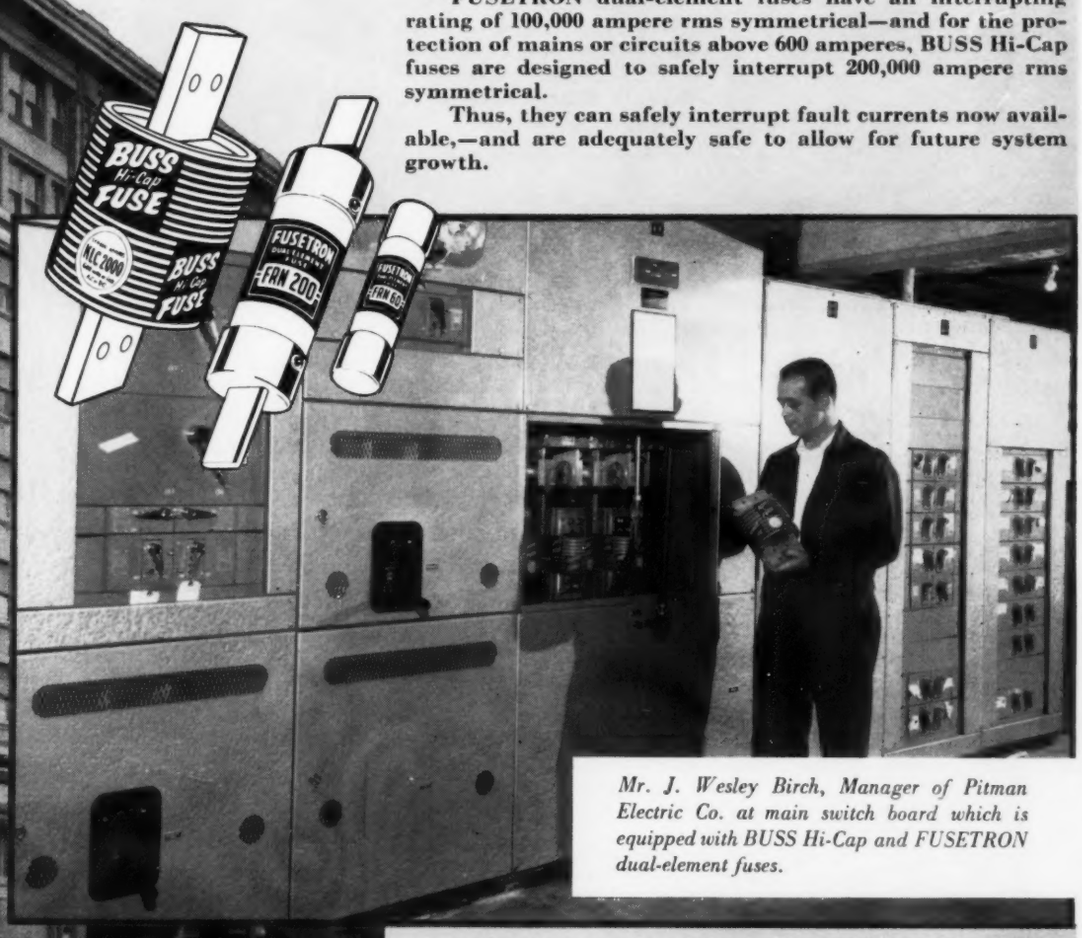
This installation is another example of the modern trend in electrical protection. Architects, engineers and plant operating men are finding no other type of protective device can equal fuses for high-interrupting capacity and lifetime, maintenance-free dependability.

FUSES PROVIDE HIGH INTERRUPTING CAPACITY

at a very low cost

FUSETRON dual-element fuses have an interrupting rating of 100,000 ampere rms symmetrical—and for the protection of mains or circuits above 600 amperes, BUSS Hi-Cap fuses are designed to safely interrupt 200,000 ampere rms symmetrical.

Thus, they can safely interrupt fault currents now available,—and are adequately safe to allow for future system growth.



Mr. J. Wesley Birch, Manager of Pitman Electric Co. at main switch board which is equipped with BUSS Hi-Cap and FUSETRON dual-element fuses.

WITH FUSES, SAFE PROTECTION REMAINS SAFE WITHOUT MAINTENANCE OR RECALIBRATION COSTS

After years of inactivity, fuses will provide the same safe, accurate protection if called upon to open as they would on the day installed.

Fuses have no hinges, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase the capacity of fuses or lengthen their blowing time.

For more information:

Fusetron dual-element fuses.....write for bulletin FIS
BUSS Hi-Cap fuses.....write for bulletin HCS

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.*
University at Jefferson, St. Louis 7, Mo.

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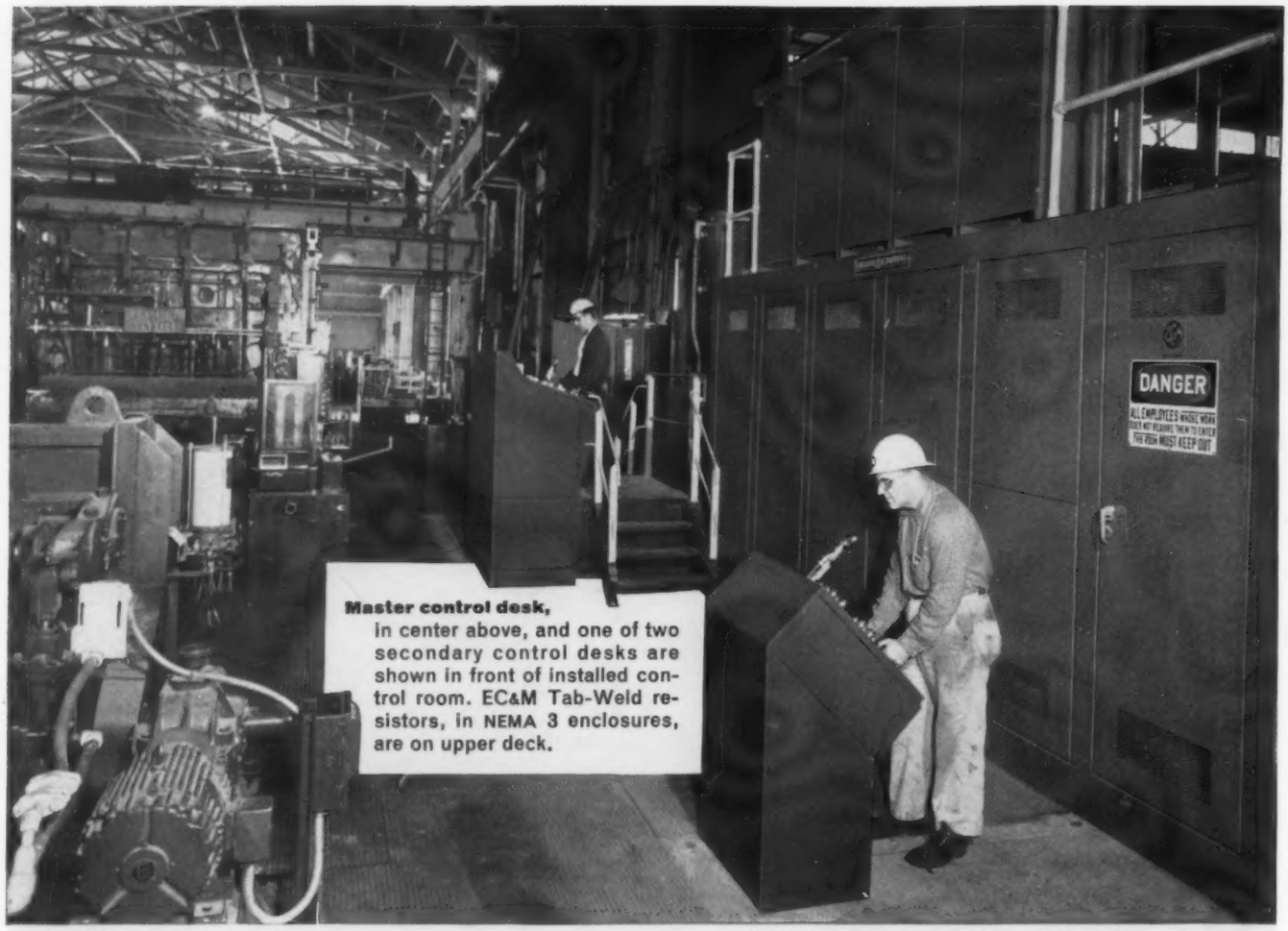
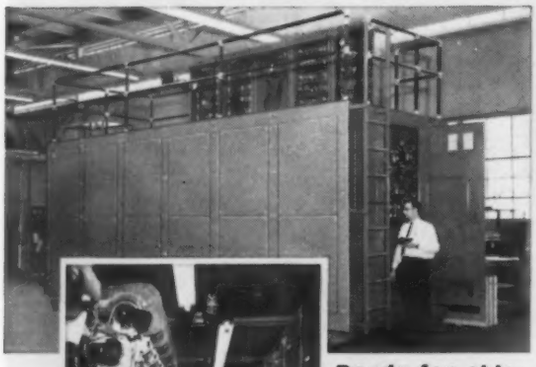
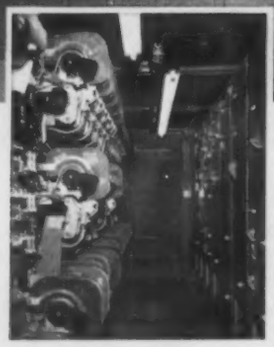
If you need fuses with long time-lag to prevent needless blows, plus 200,000 amp interrupting capacity, plus extreme current-limitation—use **BUSS LOW-PEAK** fuses.
Ask for BUSS bulletin LPCS.



Master control desk, in center above, and one of two secondary control desks are shown in front of installed control room. EC&M Tab-Weld resistors, in NEMA 3 enclosures, are on upper deck.

14-ton Mill-Line Control Room cuts installation time IN HALF!..





Ready for shipment after final test at EC&M plant.

Interior view shows DC main drive contactors at left and motor control centers at right. Framework is of heavy structural design, with 4-way safety pattern deck plates.

• This giant control room, built by EC&M for a coil welding line in a major steel mill, was installed and ready for operation in half the time usually required. Completely pre-wired and interconnected, the packaged unit eliminated the four to five weeks of installation time normally required for wiring and testing. At the mill site, the control room was placed over an open pit which already contained power cables and control wiring.

The control room measures 8 feet wide, 21 feet long and 14 feet high. It contains all the control panels for operating the DC main drives, AC auxiliary drives, and for supplying low voltage DC power for jogging and threading.

For any mill drive, EC&M can design and build a control room which will save space, drastically cut installation time and trouble, and get your drive in operation faster.

Write for details • *Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio*

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wherever electricity is distributed and controlled

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Vacuum Degassing With D-H Unit

. . . . a detailed description of the Dortmund-Horder-Huttenunion degassing equipment built for Crucible Steel Co. was given in the January, 1961, Iron and Steel Engineer. Recently, operating results were reported and follow. Final costs are still not known (refractory experience will be an important variable) and many new operational techniques will undoubtedly be developed.

TO date, Crucible has used its D-H Unit on approximately 100 heats covering the following wide variety of grades:

Carbon and Alloy

1020	4340
1040–46	5140–5160
1085–95	8620
4130	8640–45
4142	51100
4320	52100

Tool

H-11

With these grades a broad range of both furnace and D-H practices has been explored. Seventy-five-ton electric furnace and 165-ton open hearth heats have been studied. It has been demonstrated that the equipment is capable of handling effectively this range of grade, practice and heat size. The maximum alloy addition used to date has exceeded 2 per cent with no associated problems. Two-to-three times this quantity appears practical if desirable for metallurgical purposes.

The recovery of alloys has been high and consistent recovery is best illustrated by the silicon data, since the majority of the silicon needed has been added through the unit on numerous heats. A recovery of 100 per cent is obtained on most heats. The recovery of chromium averages 97 per cent, and that of manganese, 80 to 100 per cent for small additions; 95 per cent for larger additions. Chromium and manganese losses appear due to volatilization, not oxidation, as evidenced by the high recovery of silicon, a more readily oxidized, less volatile element, and by the absence of inclusions containing chromium, manganese and oxygen, as discussed below.

Product yields—Product yields from ingot to bloom from D-H processed heats have proved normal. Radical ingot method changes on D-H heats for major yield improvement have not yet been evaluated.

Control of chemistry—Composition control better than usual from the open hearth (perhaps even better than from normal electric furnace practice) at little increase in cost is one of the benefits to be achieved through the D-H unit. Ladle chemistry checks made throughout pouring show that the ladle chemistry for elements added in the D-H treatment unit is entirely uniform from start to end of the heat. Furthermore, they show that during D-H treatment of open hearth heats, the slag immediately in contact with the metal is so affected, and the metal originally lying next to the slag, so mixed with the remainder of the heat, that the slight drop in aluminum (approx 0.004) encountered at the end of a normal open hearth heat is entirely eliminated.

Improved chemistry control will tend to yield more uniform response of D-H heats to heat treatment, considered on an over-all basis. (Heat-to-heat differences and ingot segregation effects, of course, will continue to introduce some variations.)

Sulphur content—An incidental result of Crucible D-H treatments to date is a slight reduction of sulphur level, of the order of 0.002 per cent.

Grain size, hardenability and macro-etch—Grain size is consistently fine and normal. Hardenability is normal as evaluated in terms of specific heat chemistry. Macro-etch is good, with definite improvement in the center soundness of large blooms. It is hypothesized that low gas content may improve the ability of hot top metal to feed into shrinkage voids by avoiding gas rejection with the last metal to freeze. Voids free of oxide may also weld more readily.

Flake—In addition to sound centers, the absence of flake and the cooling measures necessary are of obvious interest.

Sonic inspection confirms both an absence of flake and good center soundness in sizes substantially larger than normally would be sound when produced from the same ingot by the same working methods.

Microcleanliness — Microcleanliness has been studied extensively using the usual billet and bar samples, with ratings against the usual ASTM (J-K), Chevrolet, and other applicable charts. There is a general and substantial over-all improvement in the content of oxide stringer type inclusions. In addition, Crucible finds especially improved ability to achieve low levels of oxide stringers, silicates and random oxides simultaneously.

Gas content—Though the above characteristics are the ones most

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Depend-ability

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TM Alloy Slings have a reputation for dependability . . . brute strength and low overall costs. Factory-made. Certificate of Test furnished. Bulletin 14A contains all data. Call your distributor, steel warehouse, hardware wholesaler or write—

S. G. TAYLOR CHAIN CO., Inc.
Plants: Hammond, Indiana
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Prompt repairs on alloy slings in both plants.

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commonly used to measure steel quality, some others, such as gas content, are of obvious interest. Accordingly, numerous tests beyond those normal for standard products have been made, with results as follows. Nitrogen is not significantly reduced by practices used to date from heats initially low in nitrogen, such as open hearth carbon and alloy steels. On the other hand, steels higher in nitrogen lose ¼ to ⅓ of their nitrogen during treatment.

Oxygen reductions are substantial. Percentage reductions range from 55 to 90 per cent. As may be expected, the greatest percentage reduction occurs with heats initially high in oxygen, but the oxygen removal is substantial even from heats initially fairly low in oxygen.

The question of possible oxygen pickup during teeming has often been raised. Studies by Crucible show that though this may be a significant factor for high chromium compositions, it is a negligible factor for typical carbon and alloy steels.

For open hearth heats, regardless of starting point, the final oxygen in open hearth heats tends toward one level, approximately 0.0025 per cent. For electric D-H heats, the final value is often considerably lower.

Hydrogen is effectively removed by the D-H unit. The absence of flake in tests previously described confirms this. For many of our products, size, process and product requirements are such that hydrogen removal to extremely low levels is of secondary importance to a high level of internal cleanliness. Thus, our data represent broad combinations of D-H and furnace practice aimed not so much at hydrogen removal but at our primary quality targets.

The removal of nitrogen is mechanical and least effective.

Properties—The pay-off will come primarily from improved properties and reliability. Reliability, derived from the kind of quality described above, means: (1) reduced rejections in the fabricator's plant, and (2) greater reliability, fewer premature failures and greater predictability in the end product.

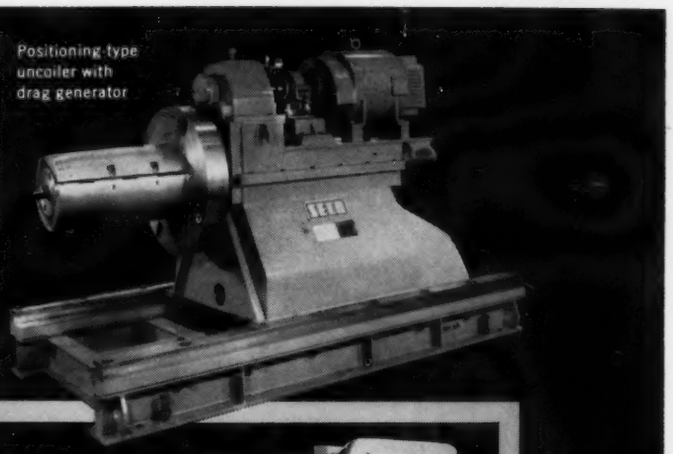
In all data of this kind, even under a single set of conditions, there is appreciable scatter. One of the important results of D-H processing to date has been to reduce this scatter to roughly half that prevailing on normal air melt material. This is very important in relation to reliability, and ability to design close to full material strength.

SUMMARY

This report must be regarded as a progress report to date, not as a final report. The equipment has been in use approximately six months. It is unique in that it is by an appreciable margin the largest of its kind ever installed, and it is substantially the most potent in terms of pumping and alloy addition ability. Much has been accomplished toward learning how to use the unit, and many practices have been tried. Some procedures yielding substantial improvement on some products are now routine. Much remains to be done to obtain optimum results in all potential areas of application. In any case, the unit provides a highly versatile metallurgical production tool for use on many steelmaking problems.

Without going into the details of the cost of operating this unit (somewhere between 0.5 and 14 per lb) results are obtained at a much lower cost than either of the other normal types of vacuum melting. The quality level produced is not quite equivalent to that of the other types of vacuum melting. Thus the product fits in to the spectrum of quality someplace between normal electric furnace quality and vacuum arc melted quality. It also means that it fits in price between the two. However, the difference in price between normal electric furnace quality and that which has gone through the D-H unit will not be as great as the difference in price between the D-H unit and vacuum arc melted material. In short, the D-H unit, in cost, is much closer to normal processing than is the vacuum arc technique. Some electric furnace steels may now be made by a combination of the open hearth and D-H unit.

As the capabilities of this unit are developed, a whole new field of possibilities for producing new grades of steel and steels that are now confined to rather difficult, specialized electric furnace practices will become available. ▲

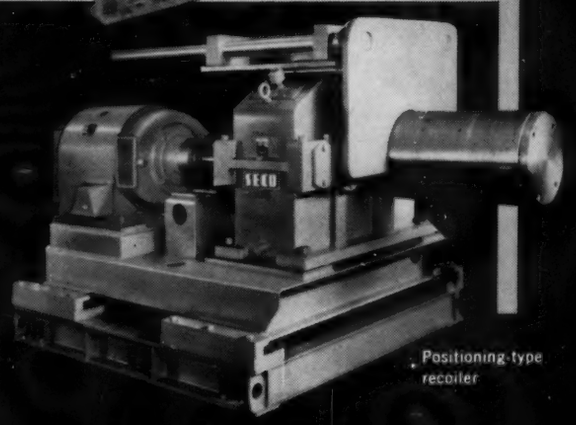


Predictable Performance

for processing lines with

SECO

terminal equipment

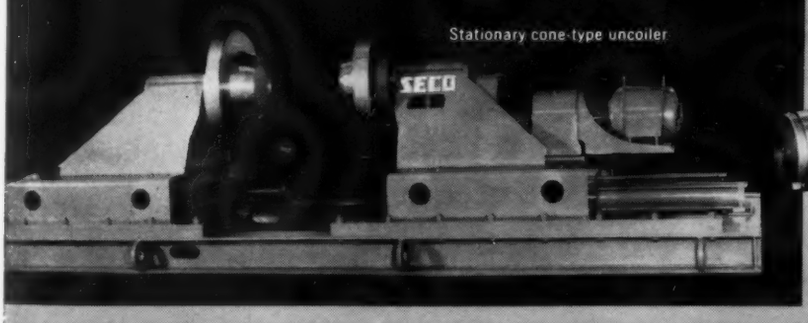


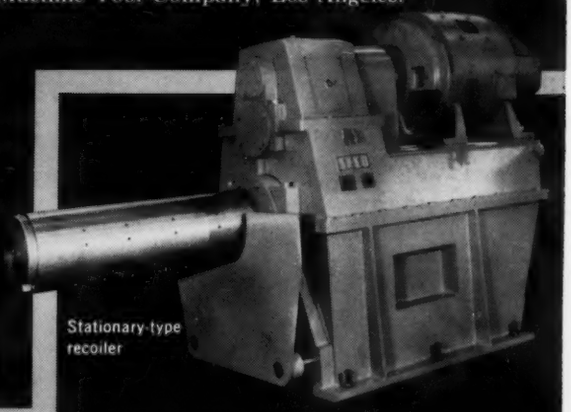
From entry to exit, new and modernized processing lines . . . annealing, pickling and others . . . perform better with SECO terminal equipment. This equipment handles coils ranging from 10,000 to 50,000 pounds with speed, convenience, safety.

SECO uncoilers and recoilers are designed to operate at any speed the mill requires, are available in positioning or stationary types. The positioning types feature a slideable reel base mounted on a sub-base for alignment with the processing line, actuated by an automatic edge control.

SECO also makes auxiliary equipment such as coil cars with coil lifts to simplify uncoiler loading and recoiler unloading. Available for mandrel or cone-type reels.

A staff of trained sales engineers will assist you in finding the equipment best suited to your needs. Call or write today. West Coast representative: United Machine Tool Company, Los Angeles.





SECO STEEL MILL EQUIPMENT

- Leveling and Shearing Lines
- Combination Edging and Flattening Lines
- Tension Reels for Strip Polishers
- Narrow Strip Grinding Machines
- Slitting Lines
- Multiple Strand Pull-out Rolls and Take-up Frames
- Strip Coilers (Up and Down Type)
- Traverse Reels for Narrow Strip
- Steel Coil Up-enders
- Scrap Ballers

STEEL EQUIPMENT COMPANY

P. O. BOX 737, WARRENSVILLE STATION • CLEVELAND 22, OHIO

Affiliated with Lee Wilson Engineering Co., Inc.

U. S. Steel Expands Its Heat Treating Facilities

THE United States Steel Corp. has assembled what is believed to be the most complete and flexible steel plate heat-treating equipment in the industry at its Homestead district works with the installation of a second continuous quenching and tempering line.

This line, now in operation at the plant's 160-in. plate mill, is designed to meet growing civilian and military demands for heat-treated steel plates. With this and other installations in the 160 and 100-in. mills and the forge division, Homestead works can treat carbon, alloy and stainless plates ranging from 0.1 to 6-in. thick and heavier.

No. 1 plate treating line, first of the two now operating, is situated along the southeast side of the heat treating and shearing building. Plates being treated on this facility are placed on the charging table of the continuous furnace, whose function is limited to heating steel to a hardening temperature. The hardening itself does not occur until the steel is cooled in a water quench. The plates are carried through the hardening furnace on a bed of motor-driven, high-alloy steel rollers at speeds ranging from 0.3 to 7.5 fpm, with the thinner plates moving more rapidly than the thicker ones.

Each plate heated in the hardening furnace is delivered to the water quench, which is sized to accommodate the largest plate. Quenching time is approximately three min per in. of plate thickness. A fast runout table section at the delivery end of the hardening furnace rapidly moves the plate into the quench, with only an anticipated 20 sec of elapsed time until the water is applied.

When a plate is in position in the quench, the transfer rollers are lowered so that the plate rests on a fixed platen. The top platen, hydraulically operated, is then lowered until it comes in contact with the top of the plate. Both platens have ribbed surfaces extending across the width of the quench, and water pipes are fastened in the recesses between the ribs. With the plate in place, ready for the quench, water sprays from the pipes play on the steel from above and below, with the top platen exerting pressure over the entire surface of the plate. Water at 80-psi gage discharges through nozzles having $\frac{9}{64}$-in. diameter holes. Extreme care is exercised to insure that nozzle holes do not become clogged for if the plate is not uniformly and very rapidly cooled, warpage occurs, necessitating releveling or perhaps retreating.

From the quench, the plate is rolled onto an electric transfer car, which delivers it to the by-pass roller tables, parallel to the tempering furnace. The plate is then transported by another electric transfer from the by-pass tables to the entry end of the tempering furnace. This furnace, like the hardening furnace, is equipped with heat-resistant steel rollers for moving the plates toward the quench. The necessity for such an arrangement is to treat armor plate, which must be quenched after tempering to improve its impact properties. This tempering furnace can also be re-

Figure 1 — Plate enters the hardening furnace where it will be heated to the proper quenching temperature.

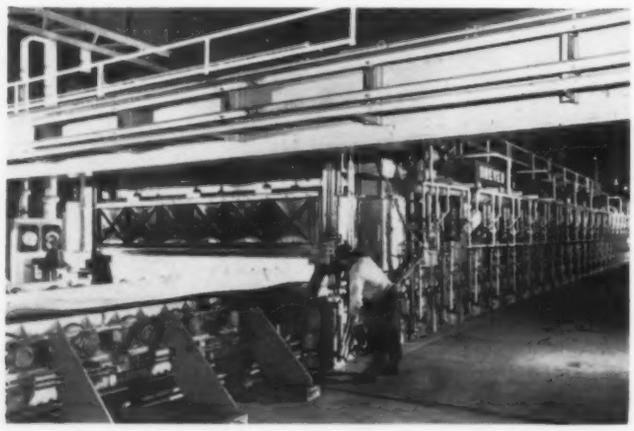
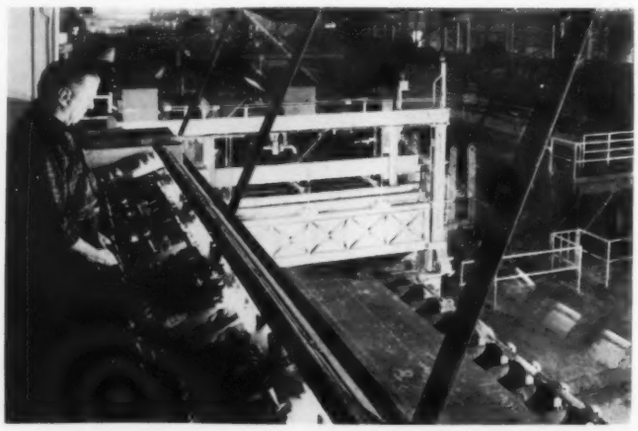
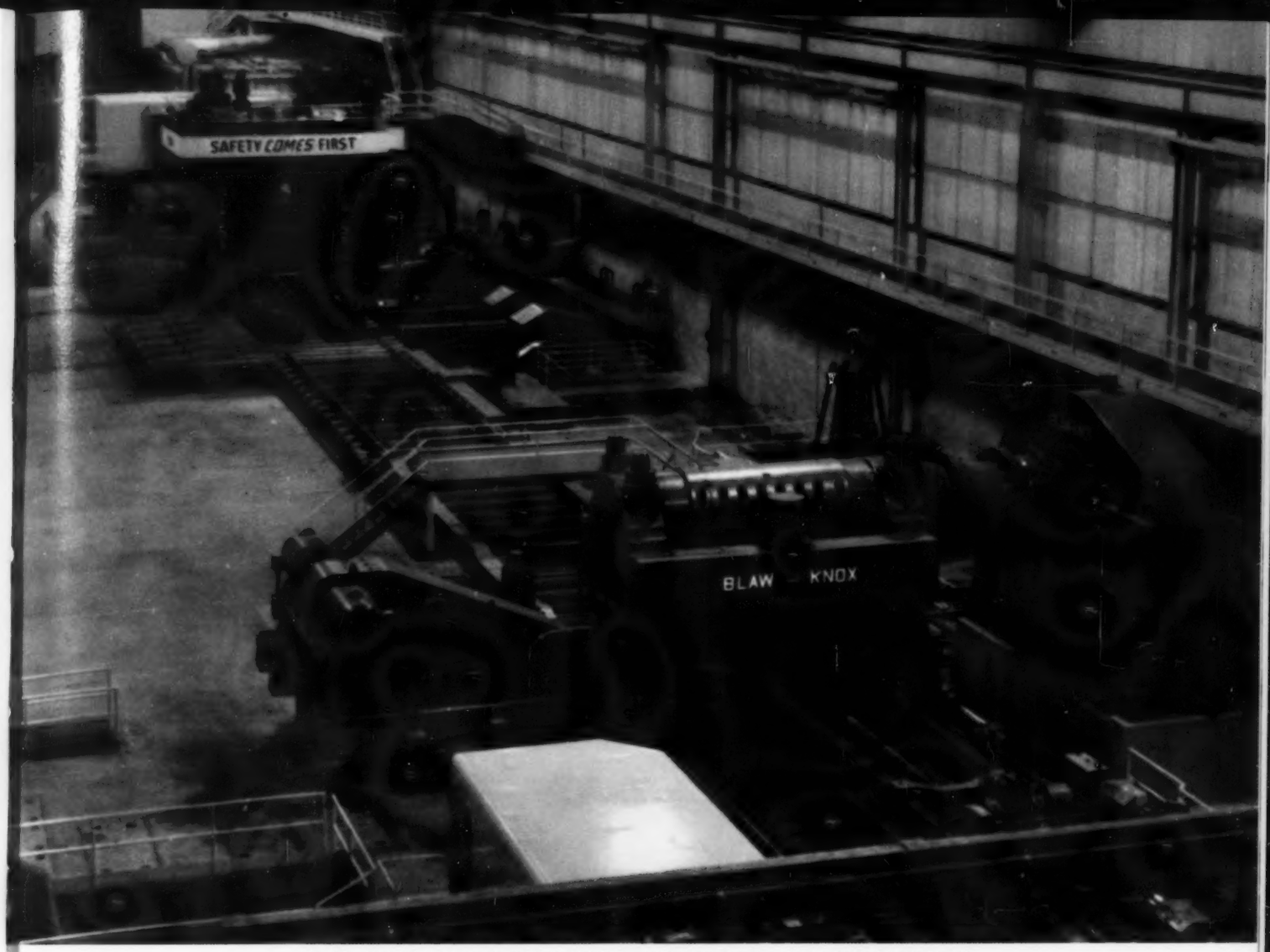


Figure 2 — The heat-treating line operations are controlled from an elevated, air-conditioned pulpit.





Combination 46- x 114-inch Blooming-Slabbing Mill and 38- x 53- x 122-inch 4-high Plate Mill.

BLAW-KNOX COMBINATION BLOOMING–SLABBING AND PLATE MILL

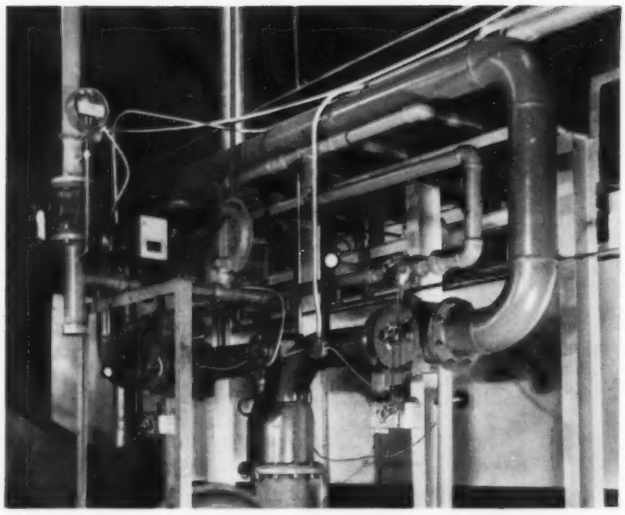
Blaw-Knox designed and built this unique Combination Blooming–Slabbing and Plate Mill. Other Blaw-Knox equipment for the metals industry includes: Complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals • Sheet and strip processing equipment • Electrolytic tinning, annealing, and galvanizing lines • Seamless pipe and tube mills • Draw benches and cold draw equipment • Blaw-Knox Medart cold finishing equipment • Iron, alloy iron and steel rolls • Carbon and alloy steel castings • Fabricated steel plate or cast-weld design weldments • Steel plant equipment • Heat and corrosion resisting alloy castings • Blaw-Knox Company, Foundry and Mill Machinery Division, Blaw-Knox Building, 300 Sixth Ave., Pittsburgh 22, Pa.

BLAW-KNOX

Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms • Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes • Towers and Special Structures • POWER: Power Plant Specialties and Valves

"FINE QUALITY-PERFORMANCE"

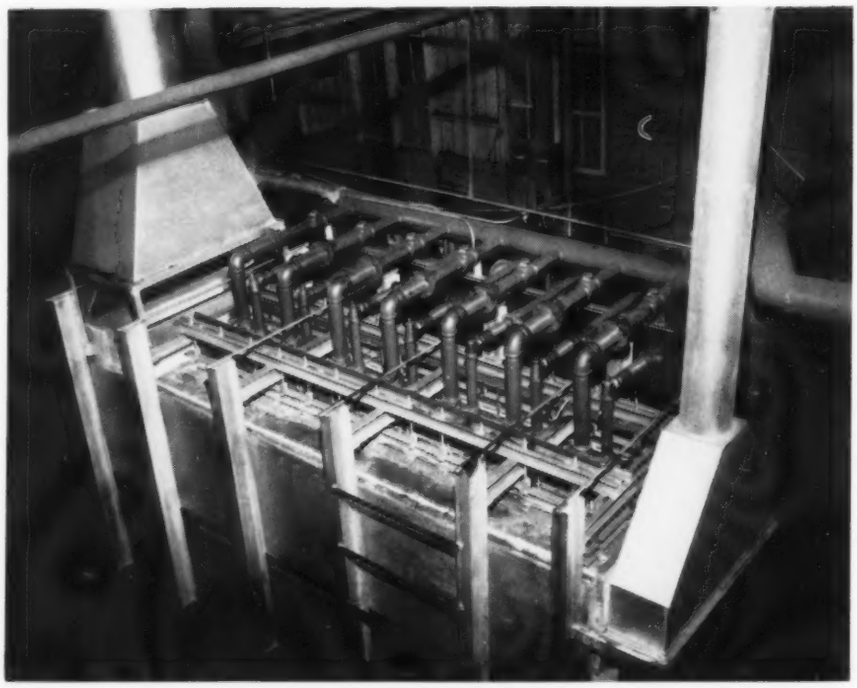
sound reasons why HAUCK is specified by The Zeller Corporation



Why Mr. Elmer E. Myers, Engineer of The Zeller Corporation, Defiance, Ohio, specified Hauck Radiant-Cone Gas Burners for use on a new pusher furnace is best explained in his own words.

"We needed a continuous pusher furnace capable of heating 4000 lbs. of steel billets per hour to 2250°F for forging Universal Joint components. We chose Hauck Radiant-Cone Gas Burners initially for our forge furnaces because we wanted to have compact, high production furnaces. Having been highly satisfied with the performance of these burners in previous forge furnaces, we designed our continuous, pusher furnace around these same type burners. Heat release in our pusher furnace is in excess of 400,000 BTU per cubic foot of furnace volume. The engineering assistance and service provided by the local Hauck, factory-trained engineer has been of the same fine quality and performance as the Hauck Hi-Radiant Cone gas burners and associated equipment."

If, like Mr. Myers, quality control, low operating cost, sound combustion engineering counsel and on-the-spot field service have a place in your plans for new or changeover firing methods, Hauck Manufacturing Company can help you. Write for technical assistance and literature describing RCG burners and engineered combustion equipment.



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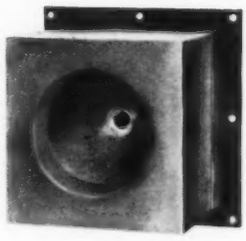


Front view of RCG burner showing refractory cone surface for radiant heat.

HAUCK MANUFACTURING COMPANY

124-136 TENTH STREET, BROOKLYN 15, NEW YORK

versed for plates that do not require quenching after tempering.

As a further indication of flexibility of operations, some carbon steel plates are normalized. In this instance, the steel is heated to the proper temperature in the hardening furnace but, instead of being quenched, is cooled in the open air.

The plates are delivered from the tempering furnace by transfer car back to the by-pass tables and again by transfer car to the delivery end of the roller leveler. With the exception of stainless steel plates, roller leveling is rarely necessary and the plates simply pass through the rollers of this machine to the cooling tables. A transfer car at the exit end of the cooling tables returns the plates to the classification building where a test coupon, partly cut from the plate at the green inspection building prior to heat treatment, is removed and sent to the plant's metallurgical laboratory for tensile and bend tests.

Upon receipt of favorable reports from the laboratory, the plate is returned from the classification building by the transfer car to the approach table of the shear line. It is passed through the turntable to the side shear where one side of the plate is sheared. Then the roller table is reversed and the plate is moved back to the turntable, turned end for end and delivered back to the shear, where the other side of the plate is sheared. The plate continues down the roller table to the end shear where both ends are sheared. Plates over one in. and through two-in. thick, the limit of the treating line furnaces, cannot be sheared on this shear line and must be sent to the heavy shearing facilities located elsewhere in the plant.

No. 2 plate treating line is located along the northwest wall of the treating building. It consists of a hardening furnace, a quench and a tempering furnace of the same size as their counterparts in No. 1 line. The transfers, by-pass tables, handling facilities, leveler and shear line are common to both lines. The following tabulation compares the two lines (all the furnaces are fired by natural gas):

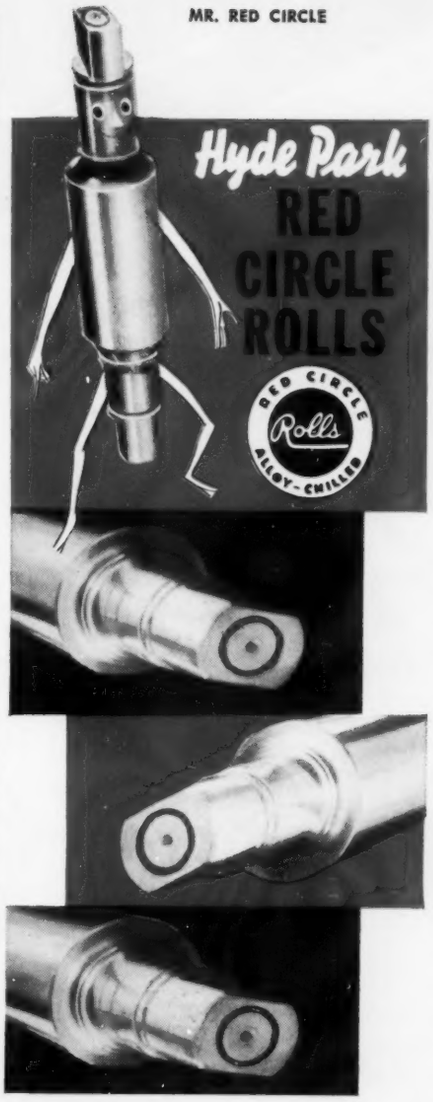
	Furnace Data				
	Hardening furnaces		Tempering furnaces		
	No. 1 line	No. 2 line	No. 1 line	No. 2 line	Stainless
Temperature limit, F	1250 to 1750	1250 to 1750	750 to 1250	750 to 1250	1250 to 2100
No. of temperature control zones	6	11	10	12	3
Available fuel input, cfhr	67,000	67,000	62,400	68,400	52,800
Average fuel input, cfhr	34,000	40,000	31,000	48,000	32,000
Roll speed, fpm					
Charging	0.3 to 7.5	0.5 to 12.5 or 20 to 80	75	0.5 to 12.5 or 87.5 to 175	50
Processing	0.3 to 7.5	5.0	0.35 to 8.75	5.0	1 to 2
Discharging	175	87.5 to 175	175	87.5 to 175	175

Completion of the new line gives capacity to heat treat in all gages and sizes rolled on the plant's plate finishing mills. Lighter and smaller plates are treated in a normalizing furnace and quench at the 100-in. mill. This combination continuous hardening and tempering furnace produces quenched and tempered plates ranging from 0.1 to $\frac{3}{4}$-in. thick, eight-ft wide and 30-ft long.

Plates too thick to be treated on the continuous lines can be treated in direct-top-fired, car-bottom furnaces in the forge division. In normal operation, plates up to 6-in. thick are treated in these furnaces, although heavier, special-order plates can also be treated.

Forged and machined steel shafting (electrical generator rotors and ship shafting) is treated in two batteries of vertical furnaces, also operated by the forge division. The first three of these furnaces, installed during 1954, will treat forgings up to 5 ft in diameter and 30 ft in length. Seven newer furnaces, installed in the plant's tallest building, were completed in 1959. Larger than the first three, these seven furnaces can treat forgings up to five ft in diameter and 40 ft in length.

Both vertical furnace installations are served by quench towers that provide a variety of quench media: water spray, fog and air. ▲



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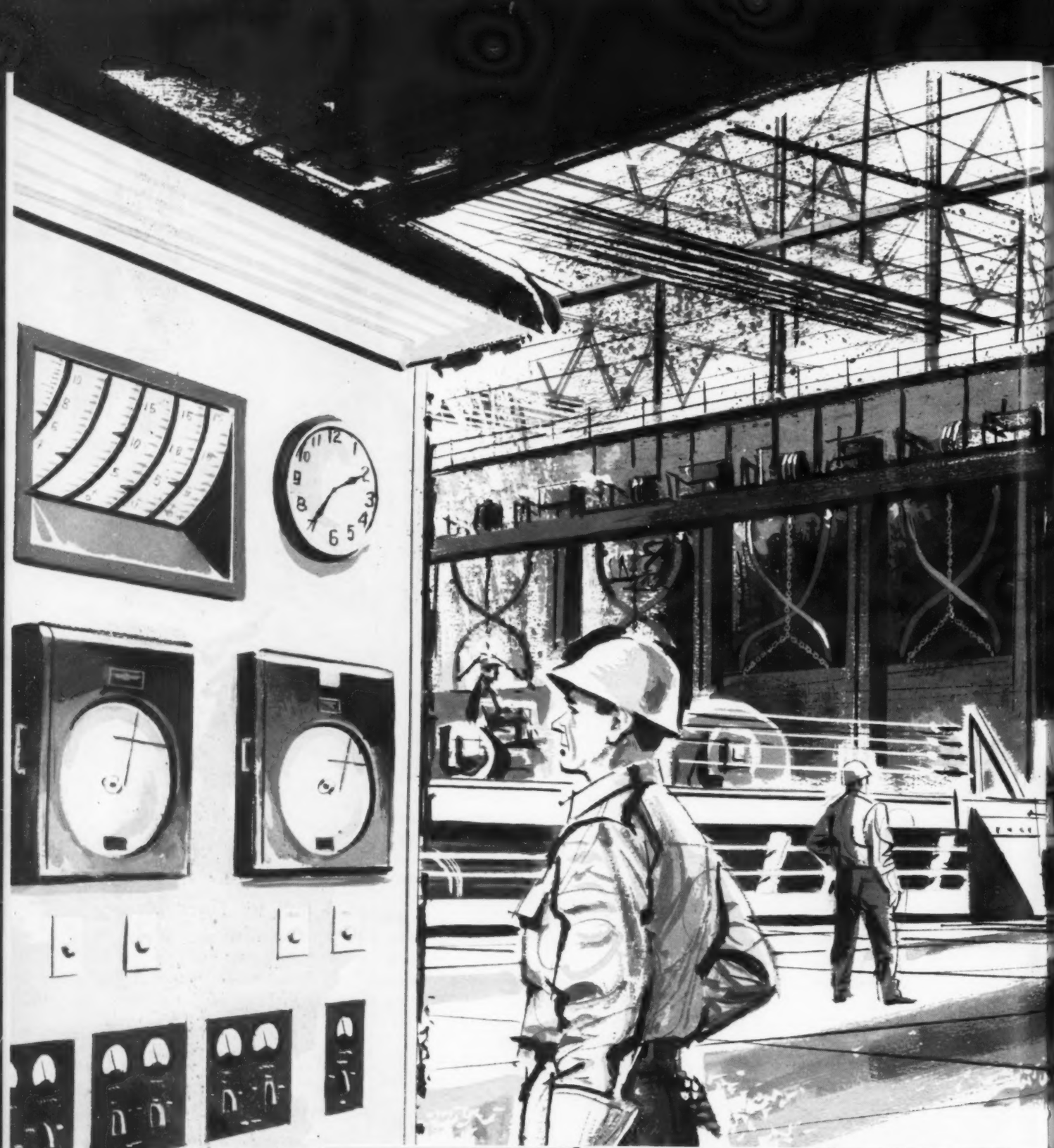
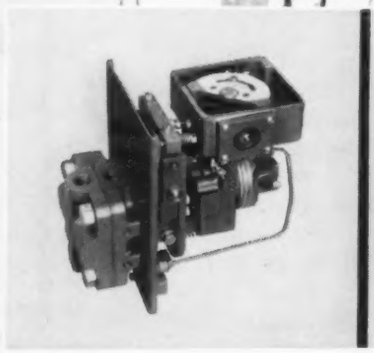
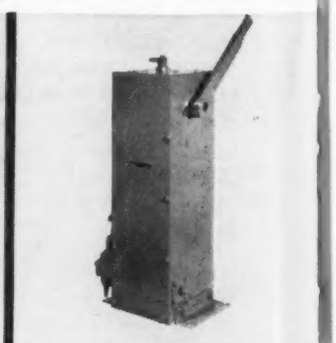




Republic VDP Differential Pressure Transmitter for oxygen and fuel/air flow measurement. VDP Transmitters belong to a new family of pneumatic instruments that use Republic's null-balance-vector principle.

Complete electronic control systems are available for controlling the various functions in an open hearth furnace. Included are transmitters, totalizers, controllers and final drive units.



Republic Final Drive Units operate valves, damper, inlet vanes, etc., in response to air loading pressures or electronic loading signals. They can be controlled automatically or manually, remotely or locally.

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Whether you are installing a new open-hearth furnace or remodeling an old one, Republic Flow Meters' complete Control Engineering Service gives you three important advantages:

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COMPLETE LINE of Republic pneumatic and electronic equipment handles the recording, indicating and controlling functions for open-hearth fuel flow and pressure, air flow, furnace pressure and atomizing steam.

On this page are illustrated a few of the many Republic products designed into your open hearth system. Wherever accuracy of response and precise control are important in the production of steel, Republic products and experienced engineering service are available to meet your needs. For information on Republic's Control Engineering Service, contact the Republic representative nearest you, or write Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada, Ltd., Toronto. Subsidiary of Rockwell Manufacturing Company.

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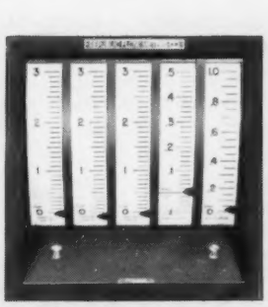
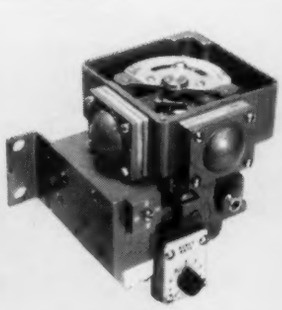
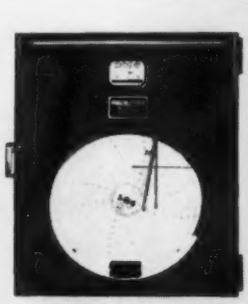
Republic-Pneumatic-electric flow meters for such applications as oxygen, dirty gases and heavy fuel oil measurements have continuous integration and remote electrical transmission.



Republic Multi-Point Indicators for drafts, pressures, flows and differentials, have large, easy-to-read scales. These multi-point indicators can be furnished for projected, flush or semi-flush mounting.



Republic VC Pneumatic Controller is an all-purpose null-balance-vector controller for use with any pneumatic transmitter for control of flow, pressure or temperature.



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FOR PUMPS, J-M CHEMPAC® (white) combines the excellent sealing and heat-resistant qualities of asbestos with Teflon's immunity to almost all chemical and solvent action. Chempac Style No. 2009 is recommended to give you long, efficient and economical service on the majority of your pump, expansion joint and agitator applications.

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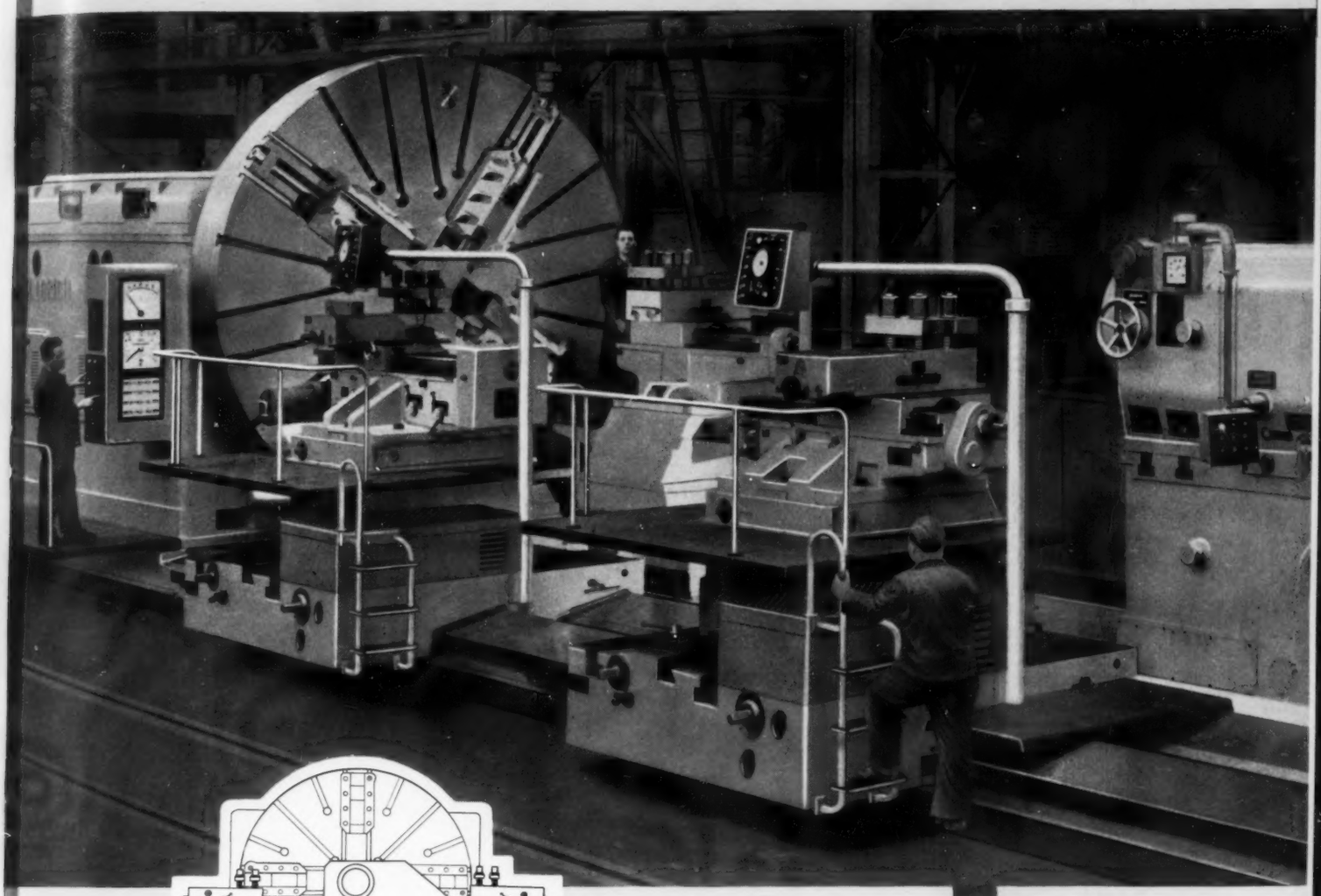

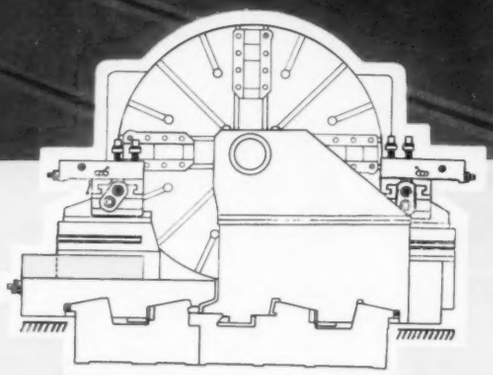

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Date-line Diary...

May 2

△ The Bureau of the Census reported that shipments of iron and steel castings in February, 1961, totaled 845,843 net tons compared to 914,023 tons in January, 1961, and 1,320,286 tons in February, 1960.

△ The price of refined copper was increased to 30¢ a lb after a series of reductions had dropped the price from 33¢ per lb in October, 1960, to a low of 29¢ per lb.

△ Allegheny Ludlum Steel Corp. plans to offer $15,000,000 of sinking fund debentures, due in 1986. Of this total $10,000,000 will be used to retire present debts, while the remainder will be used for improvement of plants and facilities.

May 3

△ The Labor Dept. reported that the number of jobless workers declined by 533,000 to a total of 4,962,000. Total employment increased by 218,000 to 65,734,000 in the period from March 15 to April 15, 1961.

△ American Iron Ore Assn. and AISI joint report shows receipts of iron ore in the U. S. for the first quarter of 1961 totaled 7,946,312 gross tons compared with 13,374,056 tons in the first quarter of 1960. Consumption of iron ore and agglomerates in the first quarter of 1961 totaled 19,231,241 gross tons compared with 34,981,518 tons in the first quarter of 1960. Total inventory of iron ore and agglomerates on March 31, 1961 totaled 55,830,777 gross tons compared with 40,479,208 tons on March 31, 1960.

May 4

△ Armco Steel Corp. announced that $50,000,000 of sinking fund debentures, due in 1986, will be offered to the public.

May 5

△ American Iron Ore Assn. reported that shipments down the Great Lakes in April, 1961, totaled 187,986 gross tons, compared with 5,600,882 tons in April, 1960. Shipments in 1961 to May 1, 1961 totaled 187,986 tons compared to 1960 shipments of 5,628,953 tons to May 1, 1960.

May 6

△ The AISI reported that steel production for the week ending May 6, 1961 totaled 1,943,000 net tons (about 68.2 per cent of capacity), compared with 1,858,000 tons one week ago (65.2 per cent of capacity) and 2,137,000 tons one year ago. Index of production was 104.3.

May 8

△ Henry J. Kaiser Co. has instituted legal action against Jones & Laughlin Steel Corp. to require J&L to pay royalties due, according to Kaiser, under a licensing agreement entered into in 1956.

△ The Bureau of the Census reports that production of titanium mill products in March, 1961, totaled 1,151,913 lb compared with 1,183,933 lb in February, 1961, and 645,276 lb in March, 1960. Production for the first quarter of 1961 totaled 3,318,780 lb compared with 1960 first quarter production of 1,939,515 lb.

△ The AISI reports that the steel industry's payroll for hourly and salaried workers in March, 1961, totaled $298,129,844, compared with $267,052,252 in February 1961. Total employment numbered 491,925 in March, 1961, compared with 484,286 in February. Payroll cost per hour worked by hourly employees was $3.455 in March compared with $3.462 in February. Average hours worked per week in March, 1961 were 36.7, compared with 35.9 in February, 1961.

May 9

△ The AISI reported that shipments of finished steel mill products totaled 5,046,523 net tons in March, 1961, compared with 4,250,720 tons in February, 1961. Direct mill shipments for the first quarter of 1961 totaled 13,918,681 net tons.

May 10

△ The Bureau of Statistics reported that Canadian steel production for the week ending May 6, 1961 totaled 121,566 tons compared to 123,936 tons the previous week and 120,240 tons the corresponding week one year ago.

May 11

△ The Bureau of the Census reports that shipments of commercial steel forgings in March, 1961, totaled 96,002 tons compared with 89,068 tons in February, 1961, and 137,906 tons in March, 1960. First quarter shipments for 1961 totaled 279,739 tons compared with 1960 first quarter shipments of 390,256 tons.

△ The Bureau of Mines reports that production of Pennsylvania anthracite in April, 1961, totaled 1,197,000 net tons compared with 1,468,000 tons in March, 1961, and 1,231,000 tons in April, 1960. Total 1961 production to April 30, totaled 6,224,000 tons.

△ The Commerce Dept. reported that U. S. gold and dollar, balance-of-trade losses in the first quarter of 1961 totaled $300,000,000, compared with $1,200,000,000 loss in the last quarter of 1960 and a $616,000,000 loss in the first quarter of 1960.

May 12

△ The Aluminum Assn. reports that shipments of aluminum sheet and plate in March, 1961, totaled 125,166,000 lb, compared with 106,308,000 lb in February, 1961, and 121,235,000 lb in March, 1960. Shipments in the first quarter of 1961 totaled 346,655,000 lb compared with 337,157,000 lb in the first quarter of 1960. Shipments of aluminum foil in March, 1961, totaled 22,286,574 lb compared with 18,835,224 lb in February, 1961. Shipments in the first quarter of 1961 totaled 60,343,686 lb compared with 1960 first quarter shipments of 57,132,230 lb.

△ The Labor Dept. reported that the average factory work week in April, 1961, was 39.5 hr compared to 39.3 hr in March, 1961.

△ The AISI reports that production of ingots and steel for castings during April, 1961, totaled 7,585,000 net tons, compared with 7,086,389 tons in March, 1961. Total production for the first four months of 1961 totaled 27,326,491 tons.

May 13

△ The AISI reported that steel production for the week ending May 13, 1961 totaled 1,988,000 net tons (69.8 per cent of capacity) compared with 1,943,000 tons one week ago (68.2 per cent of capacity) and 2,102,000 tons one year ago. Index of production was 106.7.

May 15

Δ The Bureau of Mines reports that consumption of scrap in March, 1961, totaled 4,449,000 gross tons compared with 3,925,802 tons in February, 1961; consumption of pig iron in March, 1961, totaled 4,131,000 gross tons compared with 3,612,759 tons in February, 1961.

May 16

Δ Anaconda Copper Mining Co. increased the price of refined copper to 31¢ per lb.

May 18

Δ The Dow-Jones industrial average registered the highest point in its history when it rose to 705.82.

Δ Commerce Secretary Hodges announced that personal income in April, 1961, rose to a seasonally adjusted annual rate of $410,300,000,000, the highest on record. New orders and sales of durable-goods manufacturers in April, 1961, rose four per cent over the March, 1961, figure.

May 20

Δ The AISI reported that steel production for the week ending May 20, 1961 totaled 2,037,000 net tons (71.5 per cent of capacity) compared with 1,988,000 tons (69.8 per cent of capacity) one week ago, and 2,031,000 tons one year ago. Index of production was 109.3.

May 22

Δ The Bureau of Mines reported that exports of steel mill products and pig iron in February, 1961, totaled 147,000 and 14,575 tons respectively, while imports of steel mill products and pig iron in February, 1961, totaled 152,000 and 1195 tons, respectively.

Δ The AISI reported that 1960 was a record year for tin-plate and galvanized sheet shipments which totaled respectively 5,075,500 net tons and 3,057,000 net tons. Light gage mill products totaled 71 per cent of the 71,000,000 net tons of finished steel shipments in 1960.

Δ The ARCI reported that deliveries of new freight cars in April, 1961, totaled 2933, compared with 3874 in March, 1961, and 5569 in April, 1960. Orders in April, 1961, totaled 2040 compared with 1796 in March, 1961, and 5540 in April, 1960. Backlog of cars on order May 1, 1961 totaled 13,658, compared with 15,801 on April 1, 1961 and 41,003 on May 1, 1960.

Δ The Bureau of the Census reported that net shipments of aluminum pig and ingot in March, 1961, totaled 115,479,000 lb compared with 116,848,000 lb in February, 1961, and 165,848,000 lb in March, 1960. Net shipments of aluminum mill products totaled 281,685,000 lb in March, 1961, compared with 232,547,000 lb in February, 1961, and 267,276,000 lb in March, 1960.

Δ The prices of merchant pipe stock for rigid conduit have been reduced approximately four per cent by major producers.

May 23

Δ Northwestern Steel and Wire Co. reported 1961 first quarter sales of $22,255,344, net income of $1,906,235, equal to 76¢ per share, compared with 1960 first quarter sales of $21,817,178, net income of $2,377,136, equal to 95¢ per share.

Δ The Aluminum Assn. reports production of primary aluminum in April, 1961, totaled 144,637 tons, compared with 152,022 tons in March, 1961, and 168,596 tons in April, 1960.

Δ Carloadings of the nation's railroads increased for the first time in more than a year, in March, 1961. First quarter 1961 loadings were off 15.8 per cent, compared to total freight volume in 1960 which amounted to 30,400,000 cars.

Δ The National Machine Tool Builders Assn. reports that net new orders of cutting and forming type machine tools in April, 1961, amounted to $48,900,000, compared with $70,050,000 in March, 1961. Shipments of cutting and forming type machine tools in April, 1961, amounted to $53,050,000 compared with $54,850,000 in March, 1961.

Δ F. W. Dodge Corp. reports total construction contracts in April, 1961, totaled $3,297,699,000, compared with $3,165,816,000 in March, 1961, and $3,359,782,000 in April, 1960. April, 1961, index (1947–49 = 100) was 261, compared with 262 in March, 1961, and 266 in April, 1960, all figures seasonally adjusted.

Δ The Bureau of the Census reported that March, 1961, shipments of nonferrous castings totaled 170,896,000 lb, compared with 153,246,000 lb in February, 1961.

Δ The AISC reported that shipments of fabricated structural steel in April, 1961, totaled 318,657 tons compared with 292,361 tons in March, 1961, and 322,701 tons in April, 1960. Bookings in April, 1961, totaled 309,400 tons compared with 295,739 tons in March, 1961, and 385,740 tons in April, 1960. Backlog as of April 30, 1961 was 2,377,514 tons compared with 2,713,384 tons as of April 30, 1960.

May 27

Δ The AISI reported that steel production for the week ending May 27, 1961 was 2,077,000 net tons (72.7 per cent of capacity), compared with 2,037,000 tons one week ago (71.5 per cent of capacity) and 1,870,000 tons one year ago. Index of production was 111.5.

Δ The Commerce Dept. reported that world steel production in the first quarter of 1961 totaled 86,300,000 net tons, compared with 97,900,000 net tons in the like period in 1960. U.S.S.R. production for the 1961 period was reported as 19,000,000 tons, while Japan reported production of 6,800,000 tons.

Δ Allegheny Ludlum Steel Corp. announced 2½ to 5 per cent reductions in the base prices of stainless steel strip and changes in the extra price schedules for stainless sheet and strip.

May 31

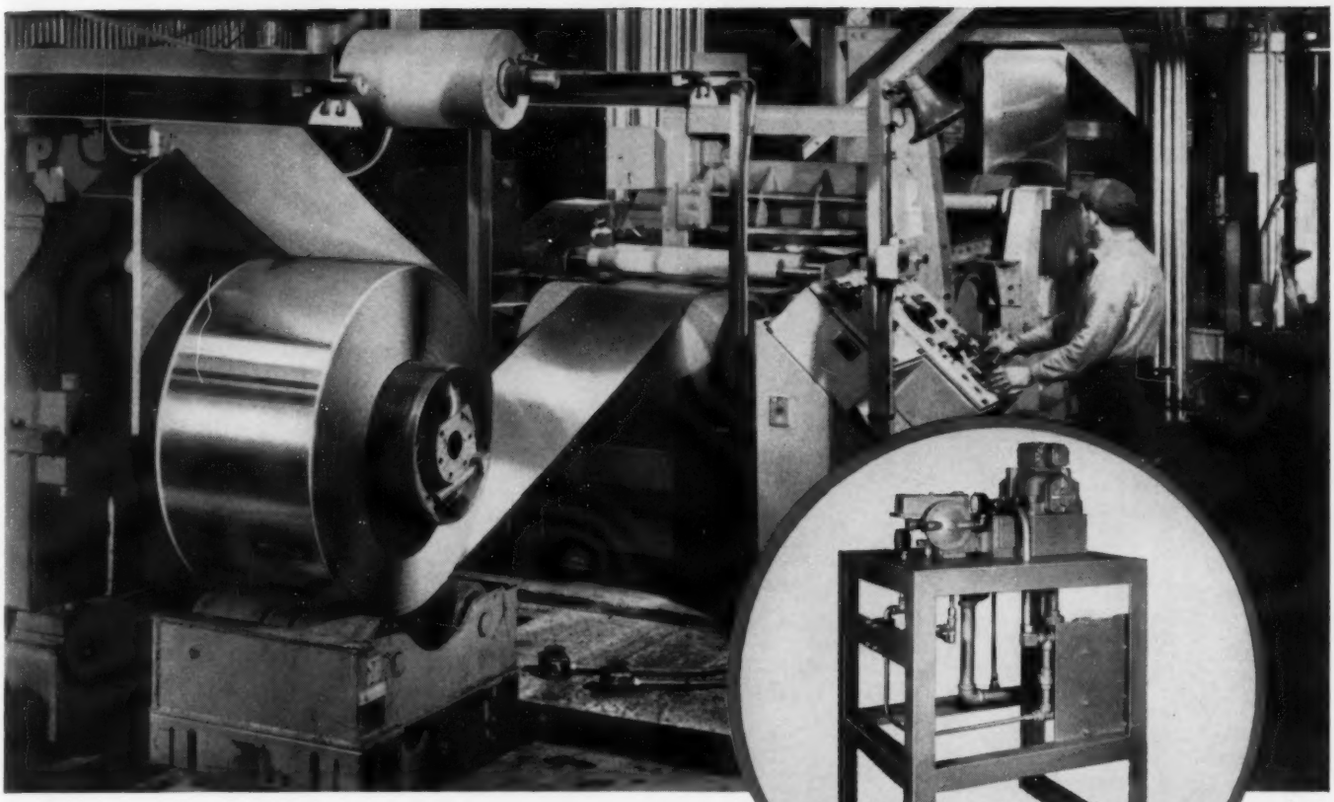
Δ American Iron Ore Assn. and AISI joint reports show receipts of iron ore in the U. S. for April, 1961, totaled 2,755,669 gross tons compared with 8,084,295 tons in April, 1960. Consumption of iron ore in April, 1961, totaled 7,112,504 tons compared with 10,432,815 tons in April, 1960. Blast furnaces operating as of April 30, 1961 totaled 129 of the existing 255. On April 30, 1960, 203 blast furnaces were in operation.

Δ The Bureau of the Census reports that construction expenditures in May, 1961, totaled $4,800,000,000, up 11 per cent from April, 1961—a nine per cent rise is normal. Spending for new construction in the first five months of 1961 totaled $20,400,000,000, an increase of $300,000,000 from the like period in 1960.

Δ Lone Star Steel Co. announced that it will relight its fifth open hearth furnace and return the company's operations to 100 per cent of capacity.

Δ Commerce Secretary Hodges reports that new orders received by manufacturers in April, 1961, increased by three per cent over the March, 1961, figures. Manufacturers total inventories increased by $100,000,000 in April, 1961, and sales in the same month rose two per cent from March, 1961.

Δ The Labor Dept. reported unemployment fell by 194,000 in the month ended May 15, 1961 to a total of 4,768,000. Employment rose 1,044,000 in the same period to a total of 66,778,000. All figures are seasonally adjusted.



Perfect alignment at top speed
—with NORTH AMERICAN EDGE CONTROL

▲ Photo courtesy Production Machinery Corporation shows re-coiler on stainless steel "bright-annealing" process.

Coiling and uncoiling goes at full speed with precise tracking—no waver, no weave, no telescoping. Perfect coils mean satisfied customers, prevent edge damage and facilitate further processing.

Handles heavy coils on modern, high speed lines. This Heavy Duty Edge Control gives instant response from variations too slight for the eye to see. Rugged as a rolling mill, precise as a jeweled watch.

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SAVE MONEY by reclaiming interleaving paper, too—using the new paper rewinder with edge control.

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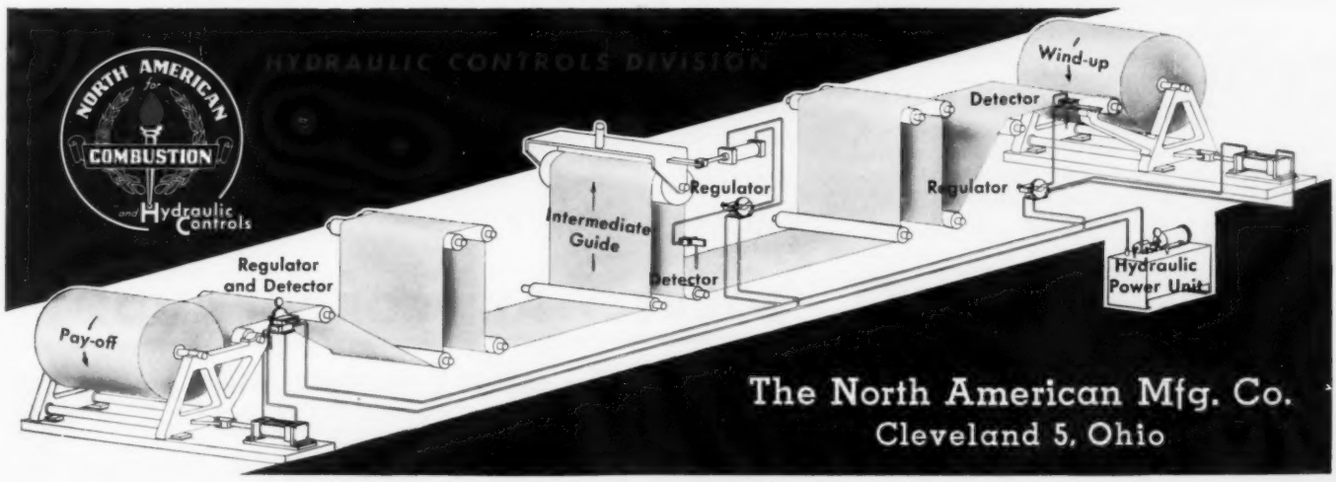

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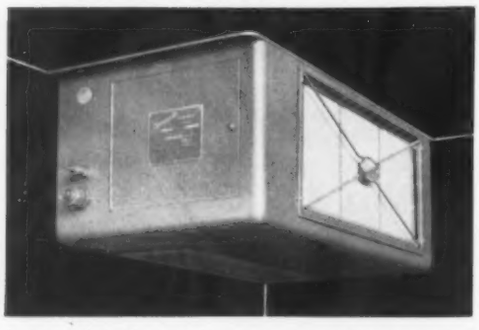

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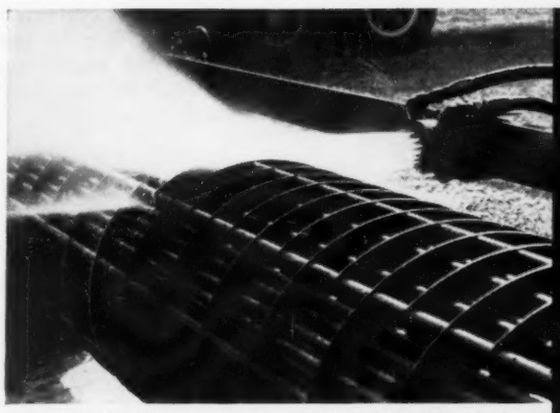
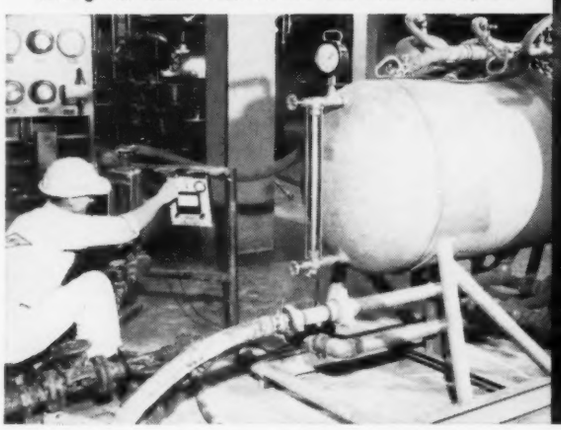


Jetting tool cleans tubes fouled with coke and asphalt.



New mobile foam-cleaning equipment cuts cleaning costs.

Cleaning missile lines and components requires tolerances as close as 150 microns.

DOW INDUSTRIAL SERVICE

Industrial Cleaning. Dow Industrial Service, now a separate division of The Dow Chemical Company, offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. This is an expansion of the cleaning service developed over the past 20 years. Dow is currently servicing entire plants as well as doing special cleaning jobs for both large and small companies.

Dow Industrial Service research in industrial chemical cleaning has developed specialized mobile equipment and techniques, some of which are pictured above. These highly efficient techniques are improving plant productivity and reducing equipment downtime in all industries using steam generators, condensers, heat exchangers, towers, water and product lines, water wells and tanks, or similar process equipment.

Product Sales and Service. The sale of specialized chemical products, scientifically formulated to be of use in specific industrial processes and to give the necessary technical service in their use, is the job of Product Sales and Service. Purifloc* N17 is an outstanding new flocculant cleared by USPHS for use in potable water.

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You'll find Dow Industrial Service offices and stations with specialized cleaning equipment and experienced personnel in all major industrial areas. For more information, write to Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio.

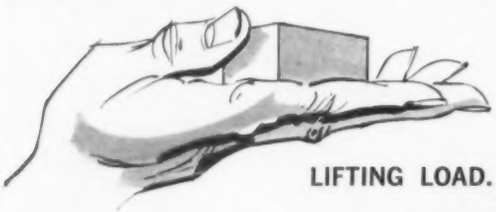
*TRADEMARK

DOW INDUSTRIAL SERVICE DOW *Division of THE DOW CHEMICAL COMPANY*

Cleveland Tramrail Stackers Serve You Like a GIANT HAND

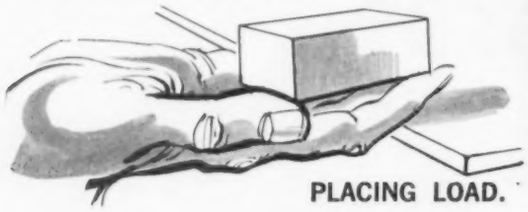
This particular stacker is rated 3 tons and lifts loads from the floor to a maximum height of 15′-6″. (Others may go higher and have greater capacity.) It may be traveled to any part of the room covered by the crane and rotated 360° either way. With load-lifting fork in high position, the clearance below stacker to floor is 8′-0″.

ENGAGING LOAD.

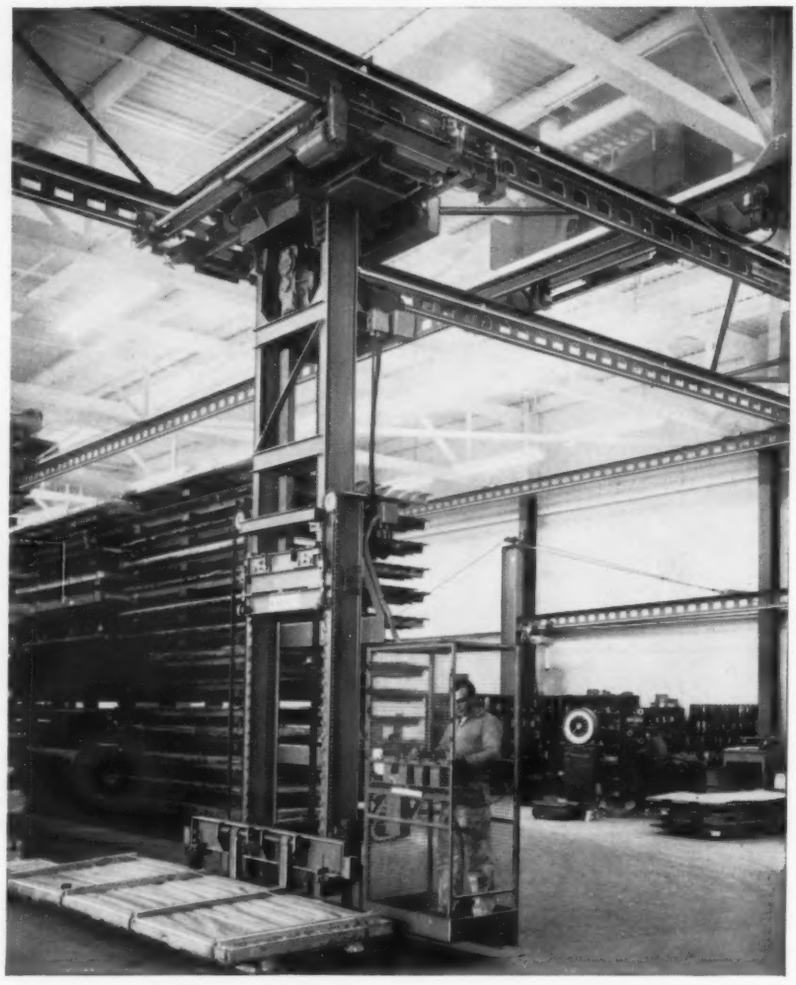


LIFTING LOAD.

TURNING LOAD.



PLACING LOAD.



Flick a controller and a Cleveland Tramrail Stacker Crane goes to work. Like a giant hand it quickly slides under a heavy load, lifts it gently and moves it wherever directed within the area covered by the supporting crane.

It is extremely flexible in action and works in close quarters to great heights. It can be rotated in either direction through 360° and more.

All motions of stacker and crane are controlled in the crane cab and can be inched for accurate positioning of the lifting fork. Loads can be spotted easily because they do not swing.

One man can handle great amounts of materials in a day without floor assistants. Some Cleveland Tramrail stackers will take materials directly from incoming trucks or railroad gondola cars directly to storage racks in one quick move. Stackers pay for themselves through time they save.

There are various types of Cleveland Tramrail stackers. They can be tailored to exactly suit your building and handling requirements. A Cleveland Tramrail sales engineer will be glad to give you the details.

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

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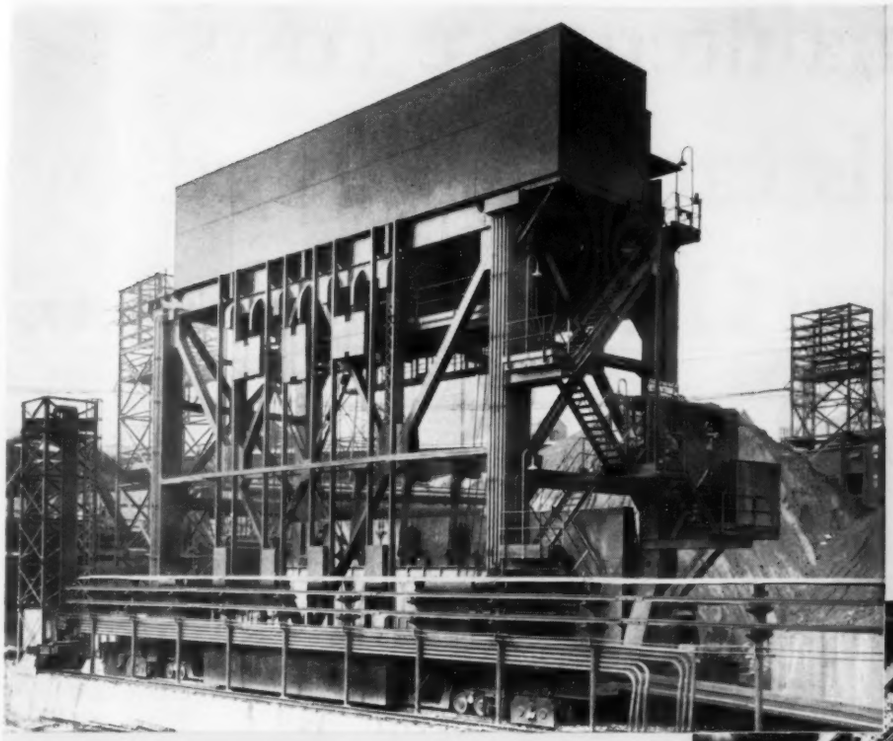

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P-G Resistors
control this 300 ton car dumper

Non-breakable Post-Glover resistors do their part in keeping this 300 ton car dumper in round-the-clock operation at Weirton Steel Company division of National Steel Corporation, Weirton, West Virginia.

These rugged, shock resistant P-G Standard Unit Resistors are built of steel and mica. With nothing to break, they have afforded low cost protection to many types of expensive and vital electrical equipment for more than twenty years.

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Write for Bulletin No. 500

THE **POST-GLOVER** ELECTRIC COMPANY

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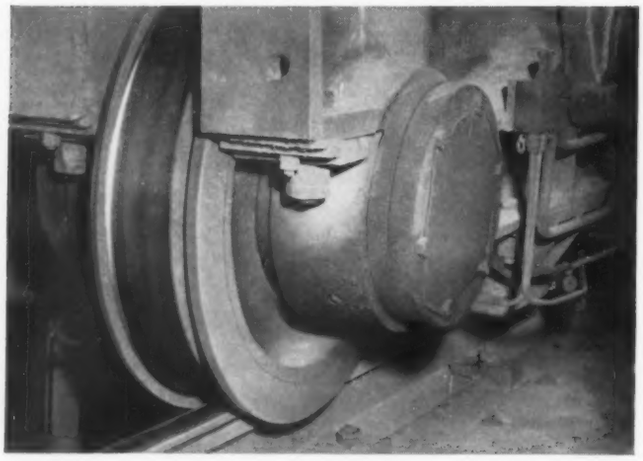
How maintenance costs in steel mills can be reduced by the Tool Steel Gear & Pinion Co. Crane Wheel Service Program



Crane wheels have long been recognized as a major source of high maintenance and replacement costs. Most steel mills have neither the time nor the equipment to carry on intensive investigations of this problem. In most cases it is assumed that the crane wheels installed on original equipment are exactly suited to the job requirements. This, of course, is not the case. Each mill uses cranes under different operating loads. Therefore, it is both wise and economical to buy crane wheels that are exactly suited to job requirements. The Tool Steel Gear & Pinion Co. Crane Wheel Service Program serves just such a purpose, and it is in wide usage throughout the Steel Industry. Here's how it works:

1. **We analyze your crane operating conditions.** Our crane wheel team, consisting of engineers, metallurgists and a TSP sales representative form a unit of specialists who meet in your plant, and in cooperation with you, carefully examine every phase of your crane wheel problem. This consists of riding the crane, appraisal of runway conditions, loading conditions, building alignment, etc. Data on wheel loading, speeds and span are tabulated. They bring their findings back to our engineering research laboratory in Cincinnati where complete facilities are available including the only crane wheel testing machine in the world.

2. **All data is correlated.** It is then carefully analyzed by our Crane Wheel Team, and a firm recommendation is made.

3. **Regular follow-up information reports are made.** After TSP crane wheels have been installed and in service for a prescribed length of time, the TSP Crane Wheel Team again visits your plant and close examination of all TSP crane wheels are made. All data is again correlated and a performance report submitted.

Basic Advantages of TSP Crane Wheels Guarantee:

All TSP crane wheels are guaranteed to last longer in the same service than any competitive wheel. High savings are achieved as a result of fewer periods of downtime and smaller labor costs in changing wheels. Fewer TSP wheels will be used than competitive wheels. Several large steel mills now using our Crane Wheel Service Program are enjoying a considerable reduction of total wheel purchases.

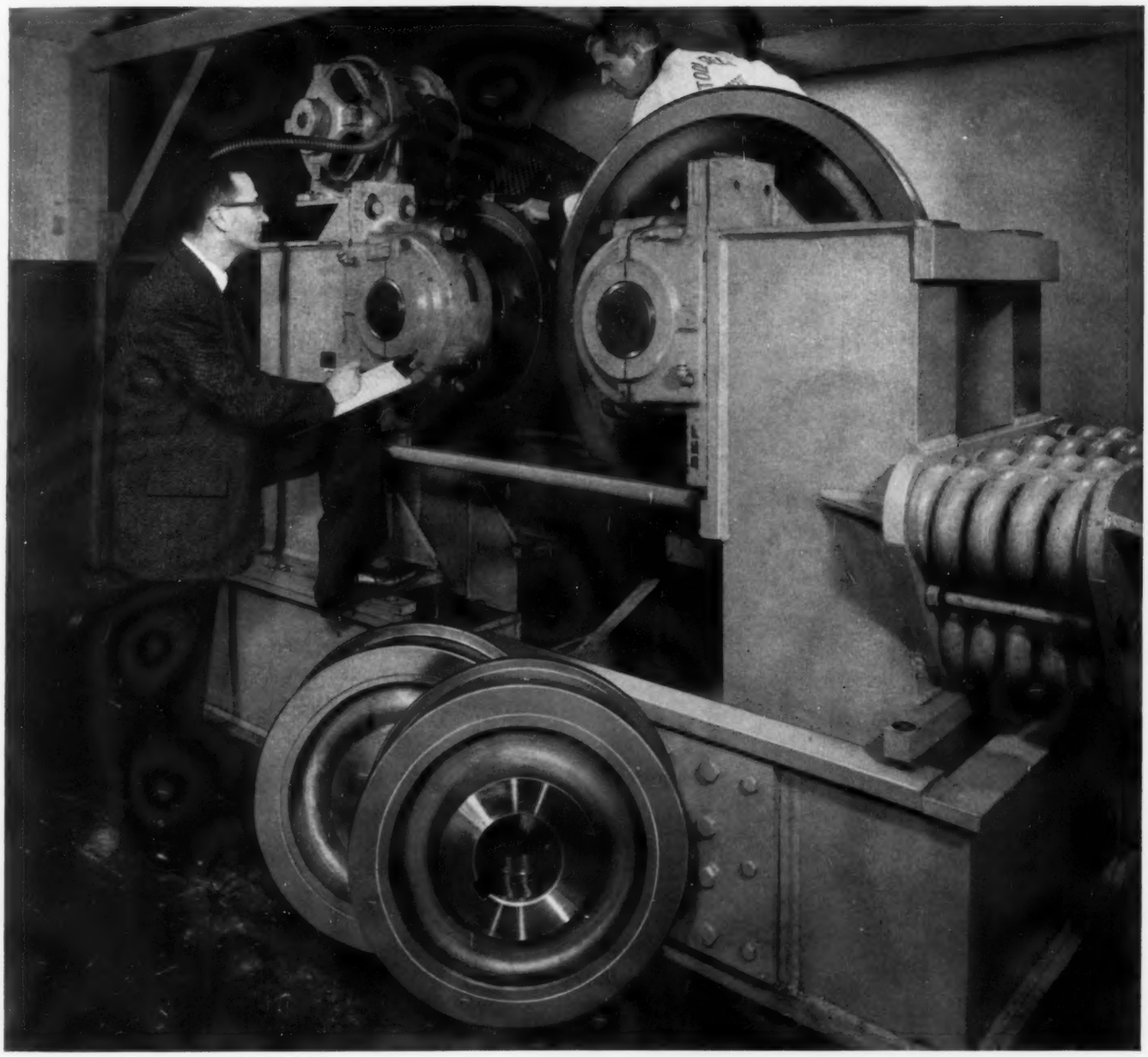
Inventory:

We are the world's largest producer of carburized and hardened crane wheels. We carry a tremendous inventory of blanks enabling us to make fast deliveries to you.

Service:

Instant service is our policy. TSP technical representatives are strategically located near all steel mill areas.

This is the Tool Steel Gear & Pinion Co.
crane wheel testing machine, the only one in the world built expressly for this purpose.
It can simulate every crane operating condition.
The data accumulated by our metallurgists and engineers permits us to produce wheels that answer perfectly, the specific service requirements of each individual crane operation.



All TSP crane wheels are hardened by our special process. A file hard surface to the full depth of permissible wear gives exceptional long wearing qualities. The core, refined for toughness and ductility, gives maximum strength. This combination, plus precision finishing, delivers a crane wheel of tremendous strength that runs smoothly under the severest conditions.

To learn more about the TSP Crane Wheel Program and how it can benefit your Company, write to Crane Wheel Dept., Tool Steel Gear & Pinion Co., Elmwood Place, Cincinnati 16, Ohio.

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Ad 1056

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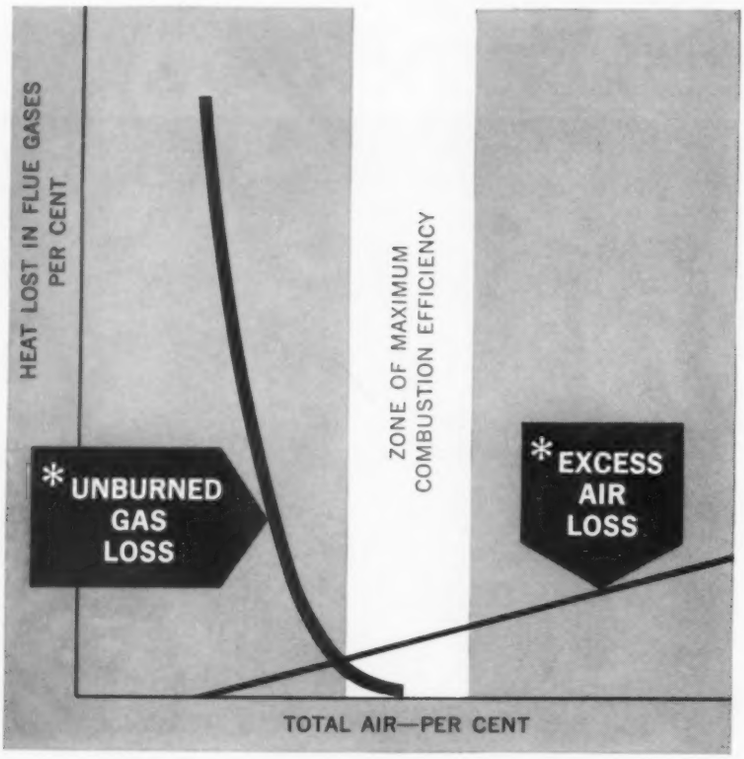
You must know BOTH* to get maximum combustion efficiency!

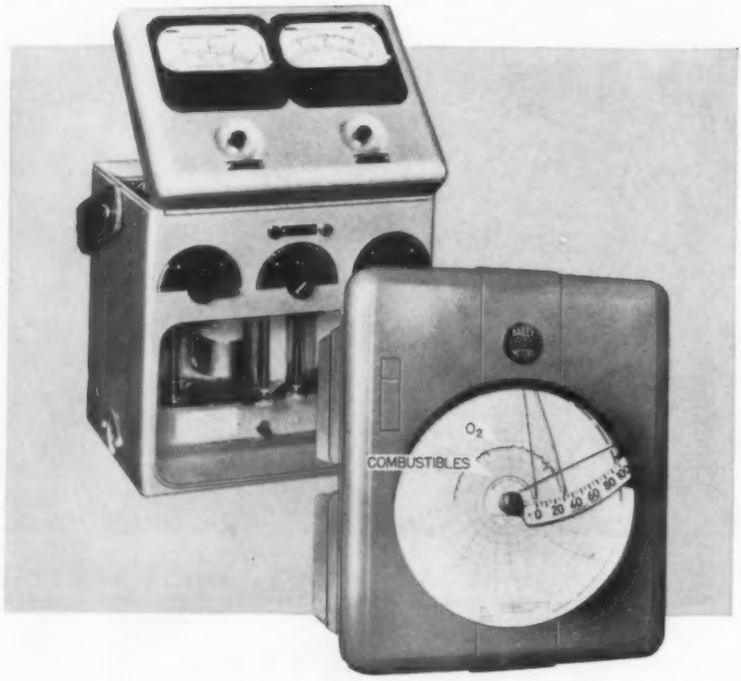

HEAT LOST IN FLUE GASES PER CENT
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
* UNBURNED GAS LOSS
* EXCESS AIR LOSS
TOTAL AIR—PER CENT

How much money is going up the flue in *unburned fuel* losses? Is too much air resulting in excessive *heat* losses?

You must know *both* facts—simultaneously—to get optimum combustion. No instrument that measures only one of these interdependent factors can give you the full information you need.

Bailey offers a choice of two direct ways to maintain a continuous and simultaneous double check on these factors that determine combustion efficiency. The portable, lightweight Bailey HEAT PROVER Analyzer indicates both; the Bailey Oxygen-Combustibles Analyzer-Recorder records both on a single chart. Both instruments measure excess air, regardless of fuel or fuels being burned, and per cent of combustibles in flue gas.

Either of these Bailey instruments can save you far more than their cost in spotlighting combustion inefficiencies. Ask your Bailey engineer or write for product specifications.



2 DIRECT WAYS to measure both combustibles and oxygen simultaneously

PORTABLE INDICATOR—Self-contained, lightweight, Bailey HEAT PROVER Analyzer enables quick, easy check on combustion conditions. Dual range dials for greater accuracy and readability.

PERMANENT RECORDER—Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart . . . is designed for permanent installation . . . helps maintain optimum ratio continuously.

* Unburned gas loss and excess air loss.

G 155-1

Instruments and controls for power and process

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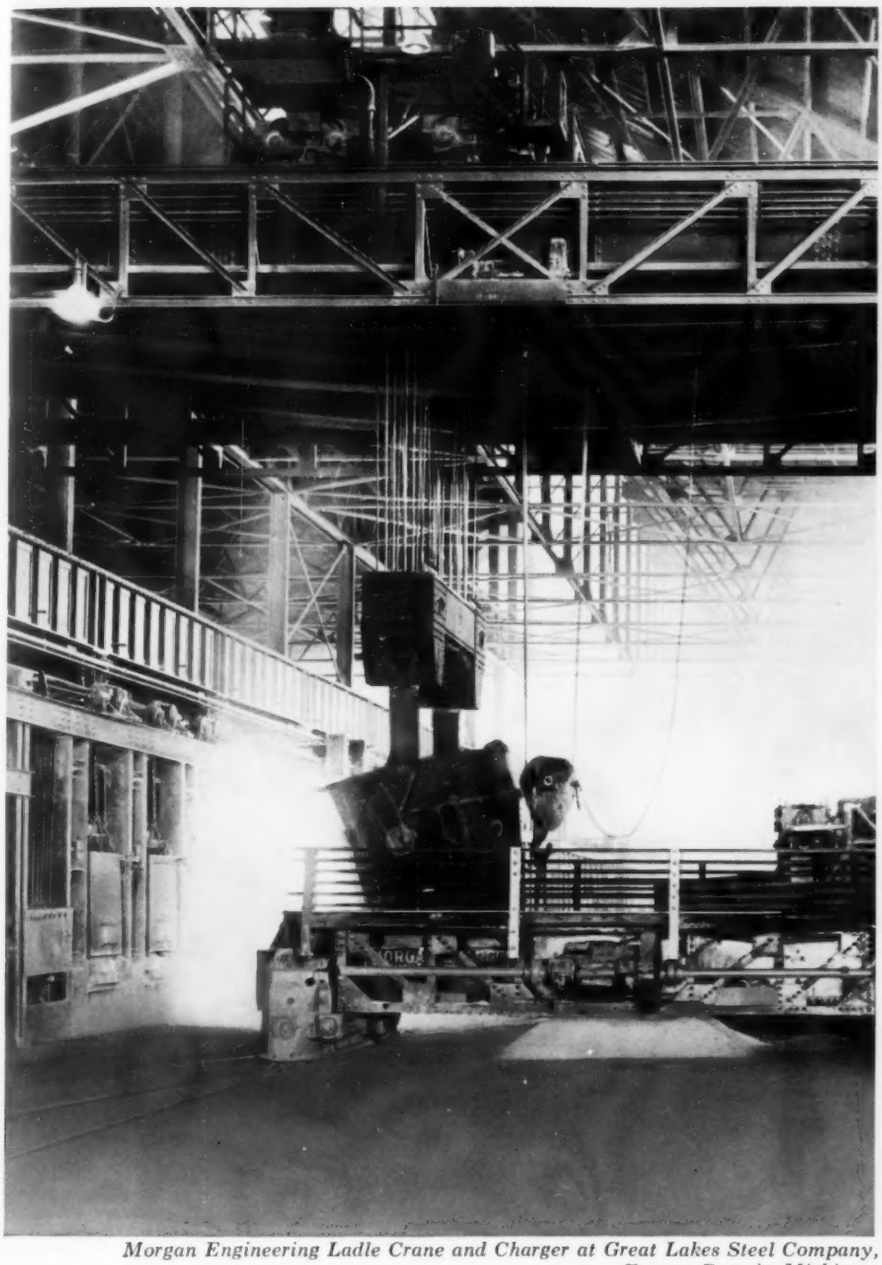

Morgan Engineering Ladle Crane and Charger at Great Lakes Steel Company, Ecorse, Detroit, Michigan

Morgan Teeming Ladle Crane

Morgan Soaking Pit Crane

At Great Lakes Steel...

NEW MORGAN CRANES SUPPLEMENT THE OLD TO BOOST OUTPUT

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Where your metal handling calls for top reliability to keep production flowing, low operating and upkeep costs to keep profits up, call for a Morgan representative. He'll advise you on the most economical equipment for your purposes.

THE **MORGAN** ENGINEERING CO. *Alliance, Ohio*

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, blooming mills, structural mills, shears, saws, auxiliary equipment and welded fabrications.

SALES OFFICES: 1754 North Highland Road, Pittsburgh 28, Pennsylvania
30 Church Street, New York 7, New York

Down go back-up roll costs with

ith, (USS) Quality Forged Sleeves

Pictured above is James S. Rennick, a metallurgist with twenty years' experience in the Forgings Division of U. S. Steel. Jim specifies composition, heat treatment, and other processing procedures essential to the production of assemblies as shown in the main picture—a back-up roll that will be used in the cold reduction tin mill at U. S. Steel's Gary, Indiana, plant.

This job points up a curious situation: U. S. Steel is one of the country's leading manufacturers of rolls, and also one of the biggest *users* of rolls . . . a double reason to perfect their performance and reduce their cost . . . just as we did here.

We had to replace a worn, cast steel back-up roll. Rather than replace the entire roll, we machined the face of the roll and shrunk on a *forged* steel sleeve. For back-up rolls like this one, 42" O.D. and larger, this method of sleeving is much less expensive than buying a complete new roll. One arbor can be used for several forged sleeves. A forged sleeve has a hard, wear-resistant surface and is highly resistant to spalling.

Also, the sleeve is purposely produced with a softer bore to develop a desirable stress pattern, and to provide maximum gripping between the arbor and sleeve after assembly.

There is a good possibility that we can help reduce *your* roll costs. Write or call the United States Steel Office nearest you, or United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

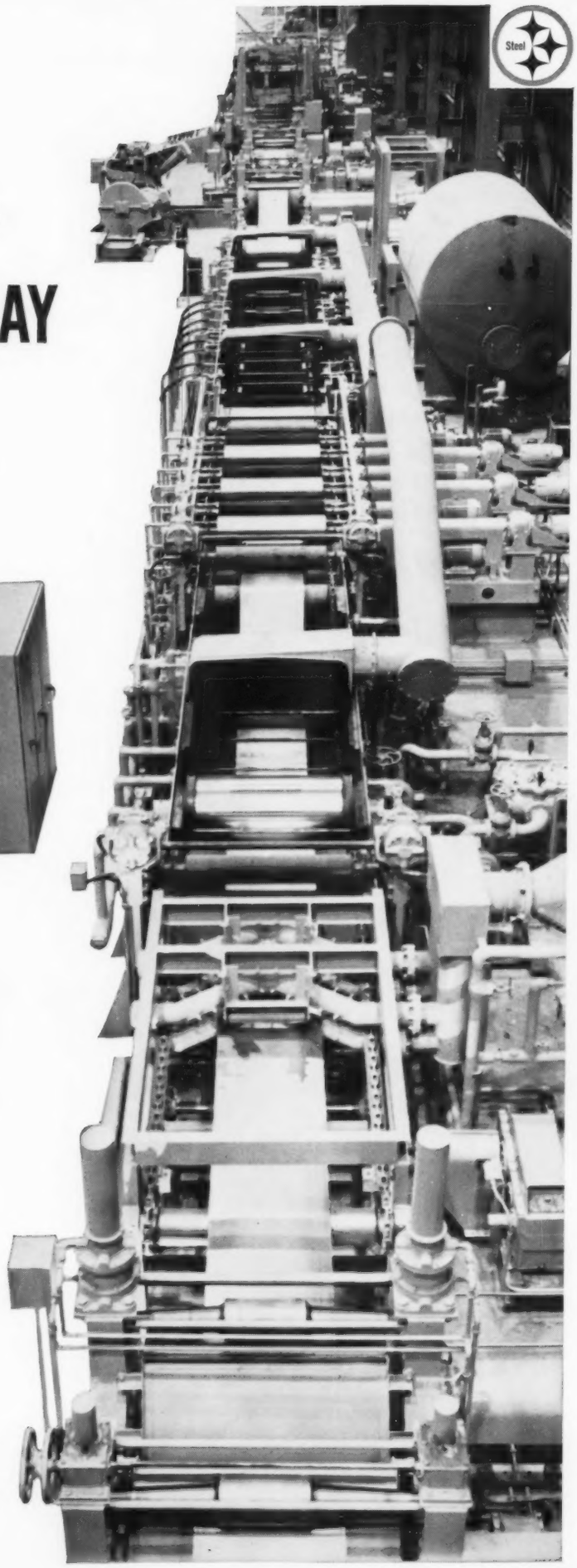
United States Steel Corporation, Pittsburgh • Columbia-Geneva Steel, San Francisco • Tennessee Coal & Iron, Fairfield, Alabama • United States Steel Export Company

United States Steel

USS

TRADEMARK

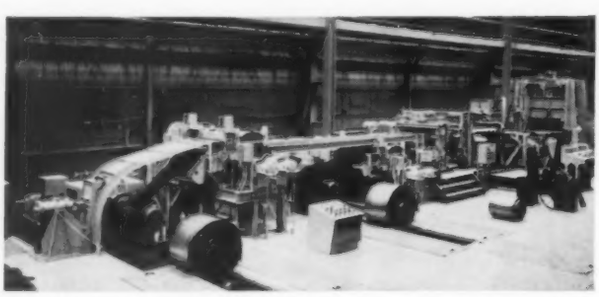
High-Speed Construction by MURRAY



In the new flat rolled products plant of Midwest Steel Corporation, Murray has completed the installation of another Aetna-Standard high speed continuous galvanizing line, and is installing an Aetna-Standard continuous annealing line.

The galvanizing line, over 915 feet long with speeds up to 300 feet per minute, was constructed ahead of schedule in cooperation with Aetna-Standard, Division of Blaw-Knox Company, for Midwest, newest division of National Steel Corporation.

Long experience, extremely competent engineering and construction personnel are responsible for Murray's High-Speed construction method . . . an important point to remember in *your* plant expansion or modernization program.



This Aetna-Standard line receives coils up to 90,000 pounds.

Murray Makes Progress

DAVID W. MURRAY COMPANY

Detroit · Toledo · Cleveland · Pittsburgh
Main Office · P.O. Box 4768 · Cleveland, O.

SIEMAG

PROGRESS
IN ROLLING MILL CONSTRUCTION

9-Stand Roughing Train of a Continuous Bar Mill

roll diameter	$17^{3}/_{4}$"
in the foreground:	2 rotary crop shears for sections up to $2^{3}/_{8}$" x $2^{3}/_{8}$"
in the background:	pusher type furnace with a max. capacity of 100 t/h, suitable for billets appr. 40 Ft long

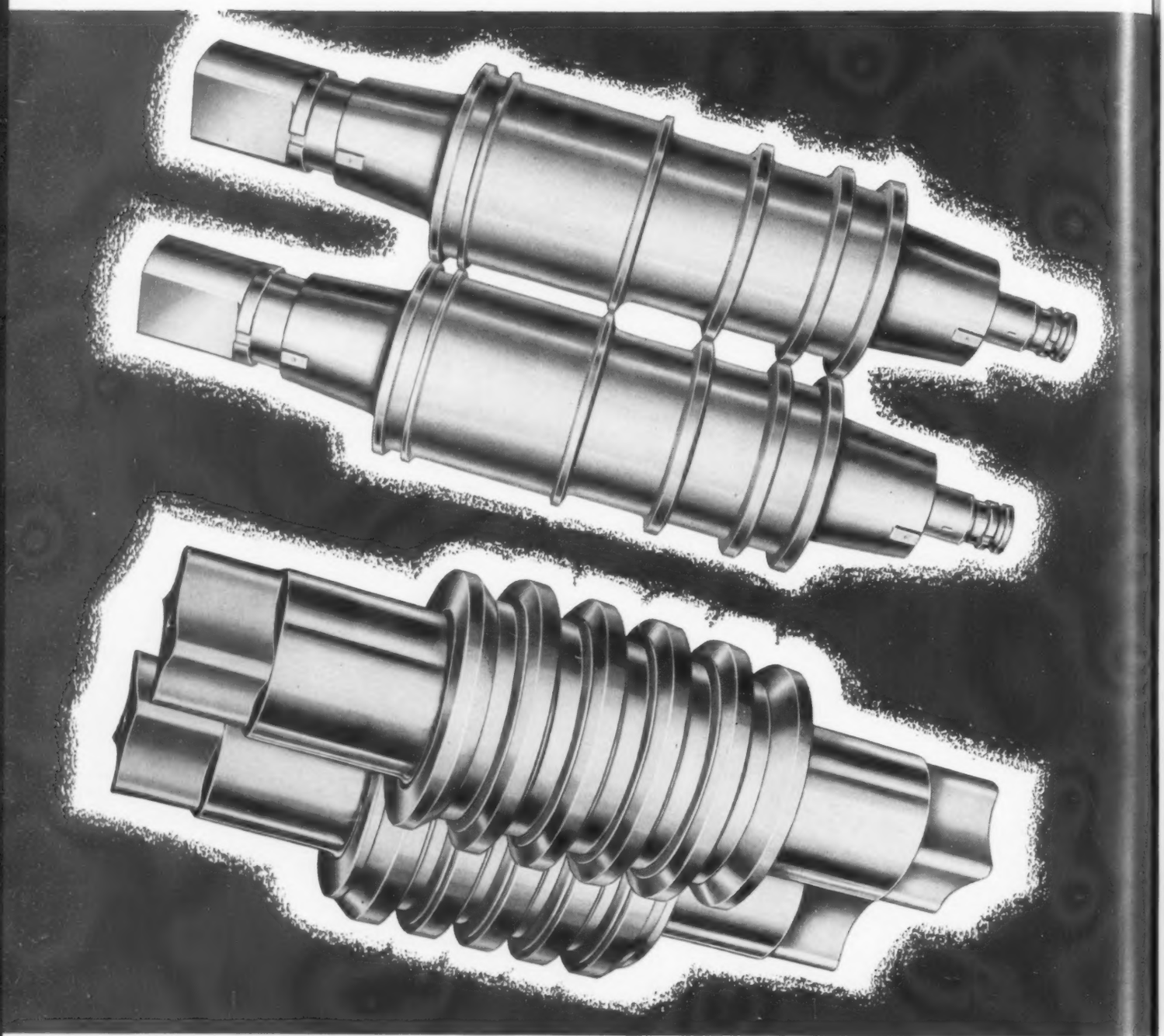
For high performance and economic service SIEMAG Rolling Mills

SIEMAG - SIEGENER MASCHINENBAU GMBH - DAHLBRUCH (WESTF.) GERMANY

Telephone Hilchenbach, Kr. Siegen, 841
Düsseldorf Office, Berliner Allee 34-36, Telephone 10091

Ohio Rolls

Shaping Metal for all Industry



THE OHIO STEEL FOUNDRY COMPANY
LIMA, OHIO

OHIO IRON and STEEL ROLLS

Carbon Steel Rolls	Flintuff Rolls	Denso Iron Rolls
Ohioloy Rolls	Double-Pour Rolls	Nickel Grain Rolls
Ohioloy "K" Rolls	Chilled Iron Rolls	Special Iron Rolls
Nioloy Rolls	Forged Steel Rolls	

PLANTS AT LIMA AND SPRINGFIELD, OHIO. . *Virtually at the center of the Steel Industry*

OR-48

Industry News...

YS&T OPERATING NEW COLD REDUCTION MILL

△ The world's first 6-stand cold reduction mill has been placed in operation at The Youngstown Sheet and Tube Co.'s Indiana Harbor Works.

It is the largest and fastest cold reduction mill in the steel industry for rolling of tin-plate strip.

The mill is designed to roll light weight tin plate almost as thin as a newspaper page. Its rated maximum speed is 7250 fpm and it can be brought up to top speed in 14 sec and stopped in seven sec.

The added mill stand permits the rolling of thinner strip at higher speeds because the work normally required of the widely used 4 and 5-stand units can now be spread out over six.

The new mill can handle coils up to 62,100 lb. Reduced to the thinnest gage this would mean a strip more than 30-miles long. Strip will measure 22 to 46-in. wide while coils will range from 30 to 80 in. in diameter.

The work rolls are 52-in. wide and vary from 19 in. in diameter in stands 1 and 2 to 23 in. in stands 3, 4 and 5 and 23½ in. in stand 6. The backup rolls in each stand are 52-in. wide and 56 in. in diameter.

The mill is equipped with the latest transistorized automatic data logging equipment to record a complete history of each coil as it is rolled. Among the outstanding quality control features is better uniformity of gage control.

The mill and auxiliary equipment are operated by 24 motors providing 34,900 hp. The 12 work rolls are driven by 20 motors providing 32,500 hp, the largest amount of electric power ever applied to a tin-plate cold reduction mill. To provide sufficient power, a new electric substation was built as part of the project for at full operation the mill uses 29,000 kw of electricity per hr.

The main drive generators, electrical control room and fire control equipment are located on the main floor, behind the mill. The basement, which covers an area almost equal to the operating floor, contains other electrical equipment, motors, fans, bearing oil and gear lubricants.

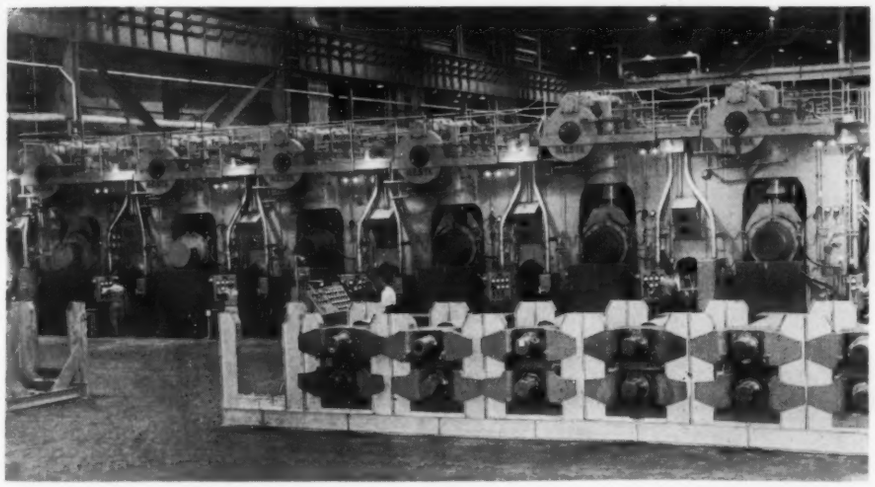
The mill is housed in a newly constructed building 615-ft long and 125-ft wide, attached to No. 2 tin mill. Two auxiliary buildings, one on either side, provide coil storage space. One building is 567-ft long and 125-ft wide while the other is 480 ft x 120 ft.

Three overhead cranes were installed in the buildings. A roll grinding and storage area also are located in the structure.

A water cooling tower was erected near the building to cool solutions heated by friction during the mill operation.

The new 6-stand facility is part of a major expansion program begun more than a year ago at the Indiana Harbor plant. Included in the program are the No. 2 continuous annealing line which has started operation and a galvanizing line scheduled to be started soon at the nearby sheet mill.

The first 6-stand tandem mill in the world is designed to roll ultra-thin tin plate.



AWARD AMSLER MORTON CONTRACT FOR FURNACES

△ Amsler Morton Co. has received a contract from Bethlehem Steel Co. to design and erect three car burizing and nitriding furnaces and one car type furnace at its Bethlehem, Pa., works.

The carburizing and nitriding furnaces will be capable of carburizing a 7000-lb charge at a maximum temperature of 1900 F or for nitriding at temperatures of approximately 1050 F.

The car furnace will be suitable for heating a charge of 10 tons of miscellaneous castings and forgings from room temperature to 1750 F.

TO DEVELOP INFRARED GAGING APPLICATIONS

△ Dr. R. Bowling Barnes, president of Barnes Engineering Co. and Philip M. Morgan, president of Morgan Construction Co., announced that they have agreed to develop applications for the Barnes Infrared Micrometer, in connection with gaging problems in rod and bar mills.

The micrometer detects the sharp thermal discontinuities at the two edges of hot steel rods, and without making physical contact, converts the radiation received into precise and continuous linear measurements.

According to Mr. Morgan, "extensive field tests in a steel rod mill confirm that the Infrared Micrometer can successfully determine the outside diameter of red hot

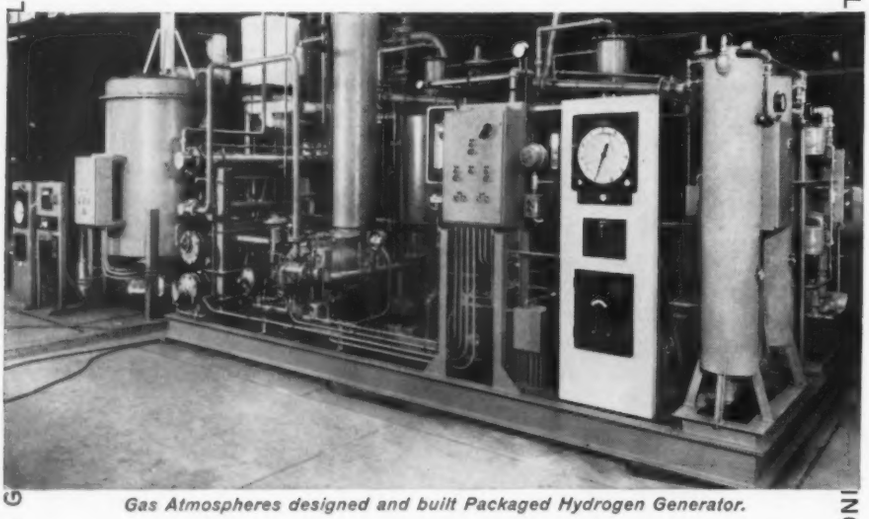
THE FANTASTIC FUTURE OF GAS ALLOYING

The potential of modern gas alloying is virtually limitless. Metallurgists are experimenting with chromium steels, soft-core abrasive-resistant steels, and low-alloy high-strength steels. Already in production:

BETTER ENAMELING STEELS, resulting from almost complete carbon removal, permit white goods manufacturers to get defect-free white or colored enamel products with a single enamel coat.

STRONGER TINPLATE, because of pinpoint control of carbon and nitrogen content. This also enables steel makers to make many grades of tinplate from a single grade of steel.

BETTER CARBON CONTROL for the production of better carbon steels. More uniform carbon distribution results in better carbon steel products. Non-aging rimmed steels are now possible, as are improved silicon steels.



Gas Atmospheres designed and built Packaged Hydrogen Generator.

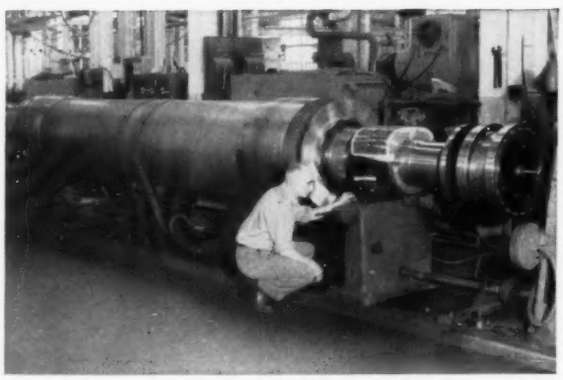
PACKAGED GAS SYSTEMS for the production of hi-purity nitrogen, carbon and hydrogen gases have helped make this revolutionary new process possible. A pioneer and leading producer of packaged gas systems designed for gas alloying is *Gas Atmospheres, Inc., 3855 West 150th Street, Cleveland 11, Ohio.*

gas Atmospheres, inc

4130

GAS ALLOYING GAS ALLOYING GAS ALLOYING

Thermal cycling ruined it...



Rewound rotor is balanced at National's plant to less than .0005" motion in free floating bearings. After complete testing, rotor was returned to service.

National rebuilds 63,333-hp rotor to last

This rotor for a wind tunnel motor took unusual punishment. Since loading of the motor continually changed, the rotor was subjected to severe thermal cycling. Expansion and contraction of coils in the slots broke down the mica ground insulation.

National rewound the rotor with new coils insulated with glass-fiber and resin. New design slot troughs of high mechanical strength were used. Now the insulation wall is extremely tough, solid and durable.

Whether your electric coil and rebuilding needs are standard or special, you'll be sure of performance when you call in National Electric Coil. We tailor-make the coils to fit your needs; offer all types of insulation. For information call National's Columbus plant... HUdson 8-1151 ... or call the nearest National field engineer.

NATIONAL COILS

National Electric Coil

COLUMBUS 16, OHIO • IN CANADA: ST. JOHNS, QUEBEC

DIVISION OF McGRAW EDISON

FIRTH BROWN

FORGED STEEL ROLLS

Forged Steel Rolls, fully hardened or semi-hardened as required, and work and back-up rolls from a few pounds in weight up to 50 tons, are Firth Brown specialities.

ALLOY STEELMAKERS · FORGEMASTERS · STEEL FOUNDERS · HEAVY ENGINEERS

THOS FIRTH & JOHN BROWN LIMITED · SHEFFIELD · ENGLAND

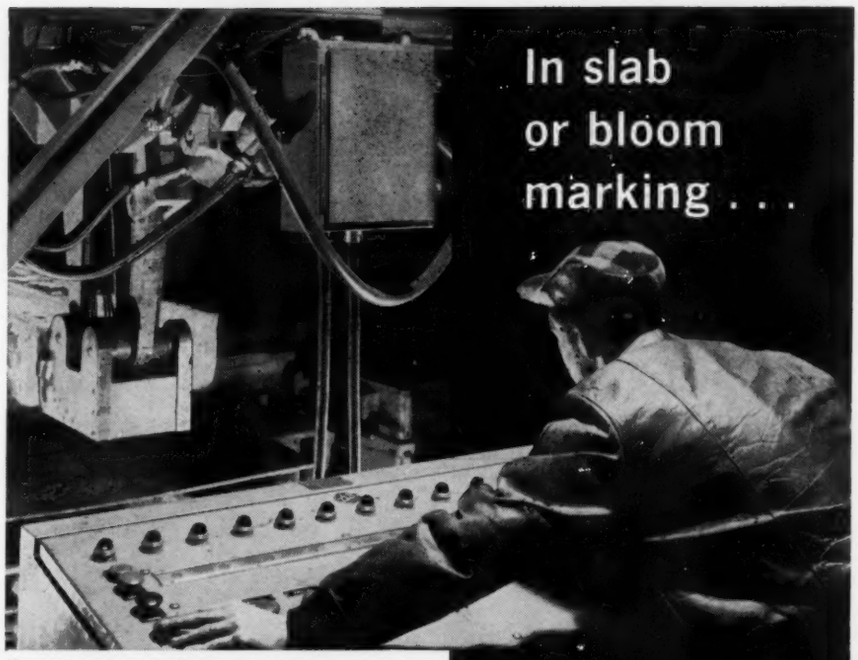
up to 50 ft. It consists of a charge table, a gas-fired, dual temperature furnace over 200 ft in length, a pressure quench, and a discharge table. The wide plate line will be used for normalizing, quench hardening and the tempering of quench hardened plate. Construction will begin this spring.

RADIO CONTROLLED CRANE OPERATING AT RYERSON

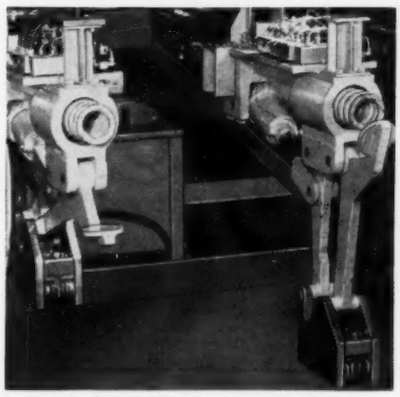
△ Among innovations in operating equipment at the Chicago plant of Joseph T. Ryerson & Son, Inc., distributor of steel, aluminum, industrial plastics and metal fabricating machinery, is a radio controlled bridge crane.

An existing crane was adapted for remote control which is accomplished by means of a battery operated transmitter worn by the operator on the floor. An antenna under the crane cab picks up the signals. A separate signal is given for each required motion of the crane. Three controls are contained in the transmitter. They give a range of five speeds forward and reverse on the hoist and bridge.

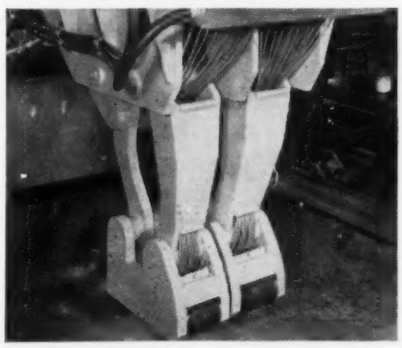
Warehouseman in the Chicago plant of Joseph T. Ryerson & Son operates bridge crane by remote control. The battery operated transmitter which he wears sends signals to an antenna located under the crane cab. From the floor, the operator moves the crane to any desired spot in the area it serves, where loads are picked up and deposited. The crane can be operated from the cab in the conventional manner.



Operator presses button to actuate stamping cycle or change characters—installed at a transfer table.



Twin units for automatic consecutive numbering of 2½" bar billets—for installation along edge of cooling bed.



Double-headed Slab Marker with 18 stamping wheels, photographed during testing—for installation over a roller line.

CUNNINGHAM
HAS THE
EXPERIENCE

17 UNITS IN SERVICE
. . . MORE ON ORDER

Under constant development for more than 13 years, Mecco Safety Slab Markers are the industry's most advanced—*the most throughly esrvice-proved,* by a margin of hundreds of thousands of tons.

We'll gladly consult with you on any phase of steel industry marking. *May we send technical bulletins on Slab Markers?*

Mecco SAFETY MARKING TOOLS

M. E. CUNNINGHAM CO.
1061 CHATEAU STREET
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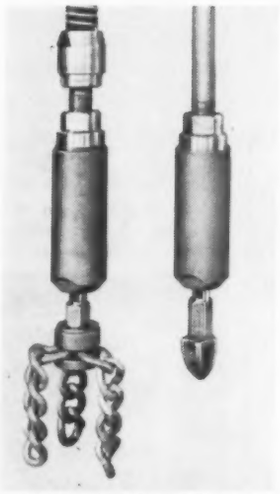
CHECKERWORK cleaned faster, better with

ELLIOTT TUBE CLEANER

Substantial saving of time and labor, and thorough cleaning of passages without harm to brickwork are effected through the use of standard Elliott tube cleaner air motor with the special whirling chain head illustrated at the right. If stubborn deposits require drilling, the same motor can be equipped with an extension piece and drill. The photographs above show how effectively square corners are cleaned. Many steel mills report savings in manhours as high as 50 percent with use of the Elliott checkerwork cleaners. Write for complete details. YO-1



Motor with chain head (left) and with drill and extension piece

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS

DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

The crane can be operated from the cab in the conventional manner. All controls are of the dead-man type, with motion automatically stopped when the control is released.

A company spokesman said the radio controlled crane had been in the development stage for about five years. It was produced to specifications prepared by the Ryerson company which worked closely with the developer.

The bridge crane presently equipped for remote control is employed in the aluminum stock section of the plant. No definite plans have been made to equip other cranes in the plant with a similar electronic device, although such action is a possibility at the firm's Chicago operation as well as at its 19 other service plants across the country.

CF&I ORDERS UNITED WIDE FLANGE BEAM MILL

△ The first mill for rolling parallel wide flange beams to be located in the western United States has been ordered by Colorado Fuel and Iron Corp. from United Engineering and Foundry Co.

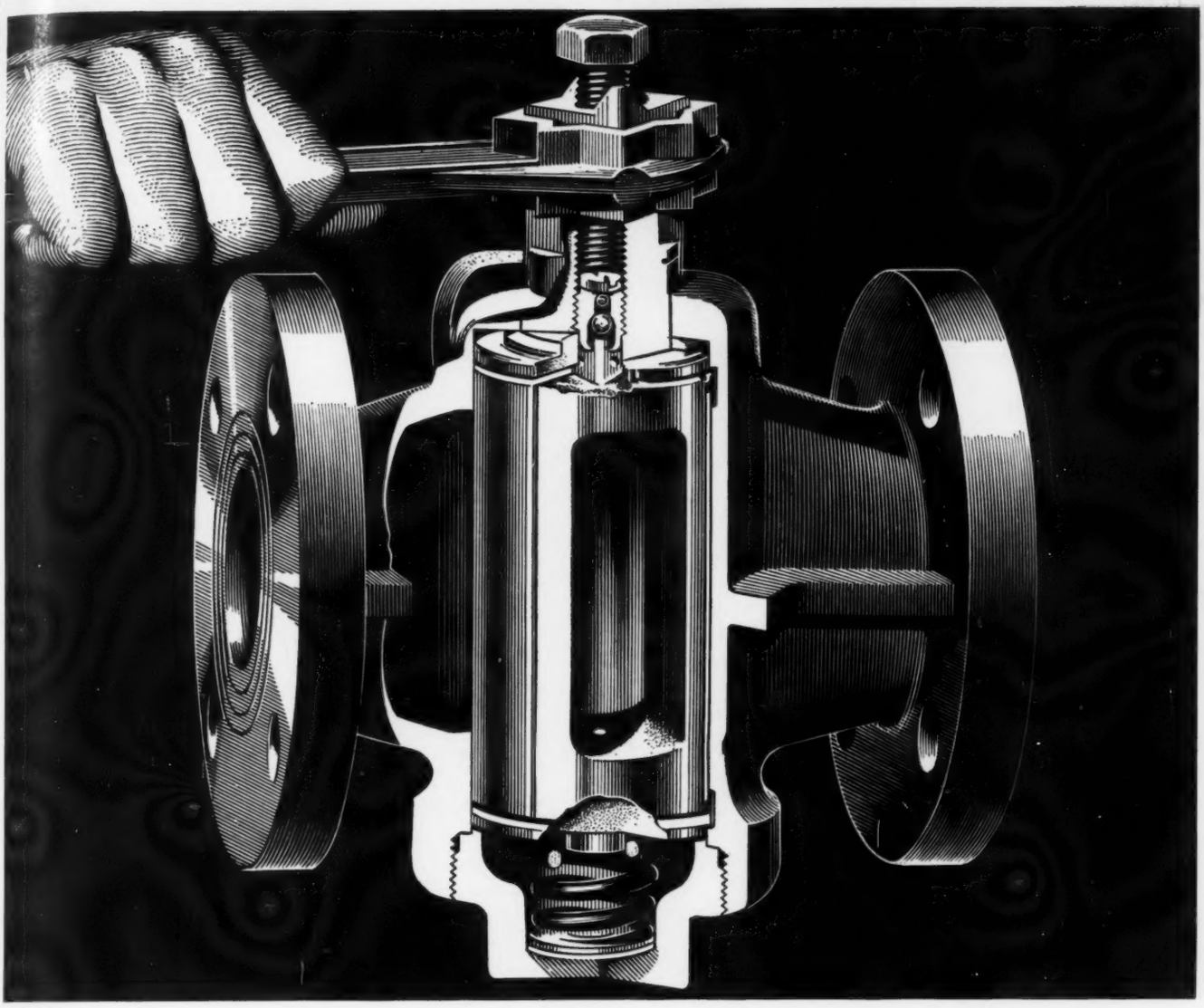
The mill is part of a $15,000,000 modernization program at CF&I's plant at Pueblo, Colo.

The wide flange beam mill will give CF&I a new product addition, improving its ability to serve the growing needs of western markets. The mill is expected to be in operation by the summer of next year.

TO BUILD GIANT FILTERS FOR SHEFFIELD DIVISION

△ Two major dust collector installations have been ordered by Sheffield Division of Armco Steel Corp., one each for their Kansas City and Houston plants. The collectors will be high temperature glass cloth filters made by Western Precipitation Division of Joy Manufacturing Co.

The two units will clean a total of 270,000 cfm with an efficiency rated at virtually 100 per cent. Western Precipitation will build complete turnkey installations at both plants including erection of the filters, spray towers, flues, fans and accessories.



HOMESTEAD® LUBRICATED PLUG VALVES

performance you can put your hand on

When you take the handle of a Homestead Lubricated Plug Valve, you know that positive low-cost fluid control is at your fingertips. This Homestead Valve is built to very close tolerance, vital to long, effective operation—two thousandths of an inch maximum tolerance on sizes up to 2″ and three to five thousandths on larger sizes. Its *controlled* high pressure lubricant system guarantees complete coverage of sealing surfaces; protection against corrosion; no contamination of line fluids; and no-stick opening or closing thanks to the downward movement of plug during each lubrication. In short, you get performance you can count on with Homestead Lubricated Plug Valves. Get the full story in Reference Book 39-1. Send for your free copy today.

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"Serving since 1892"
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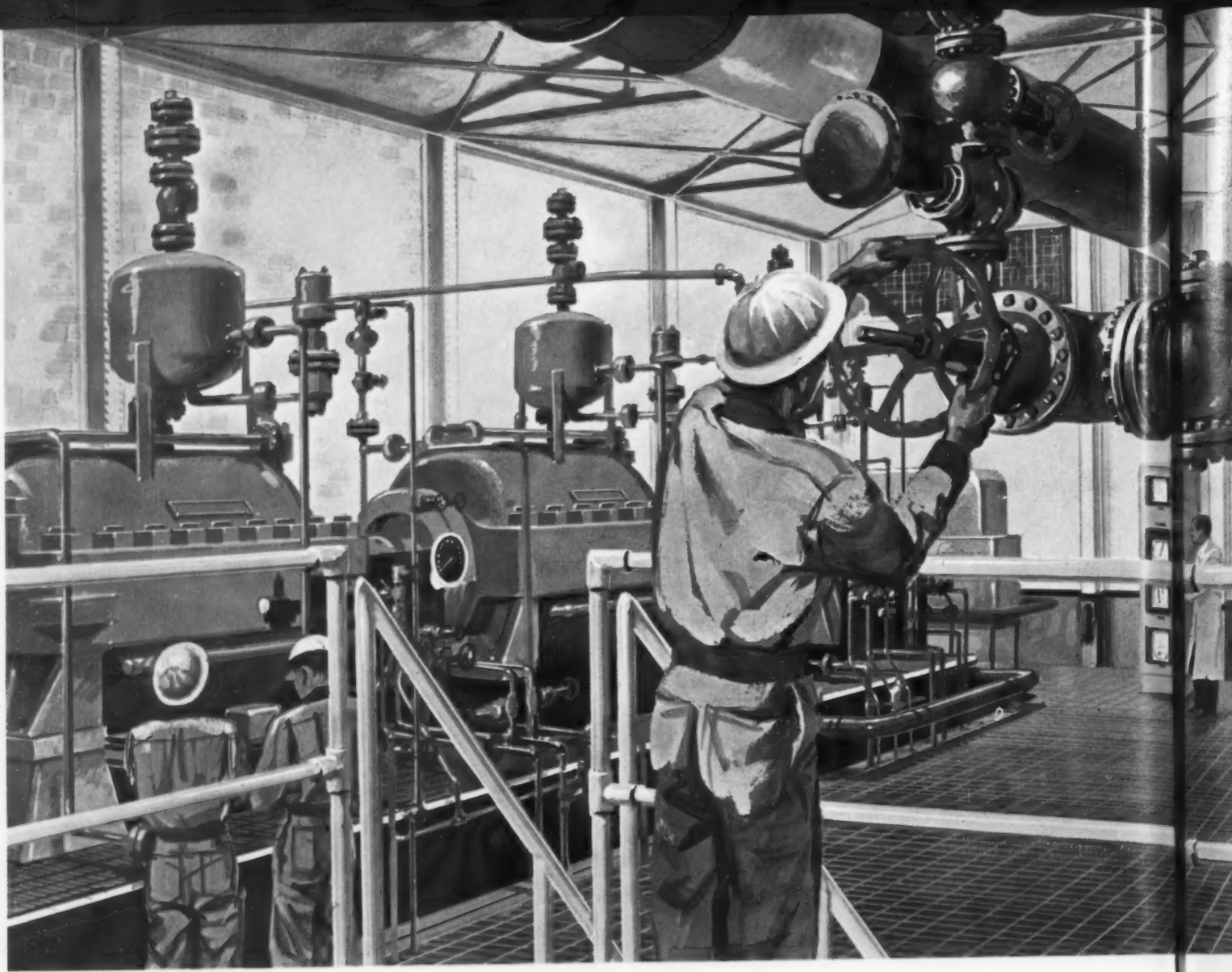
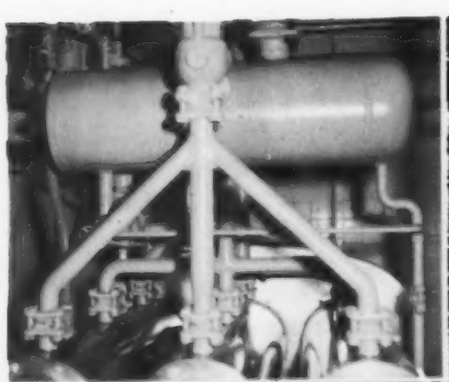
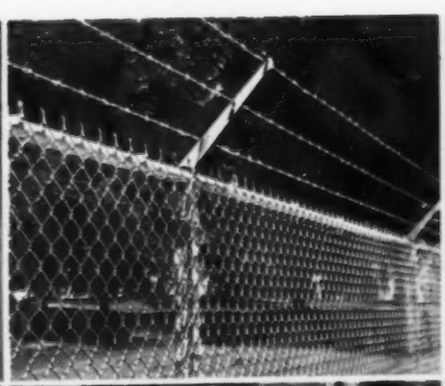
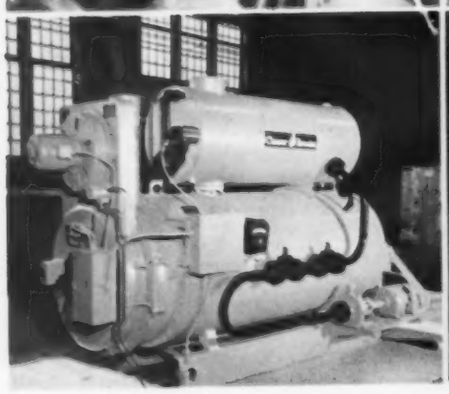
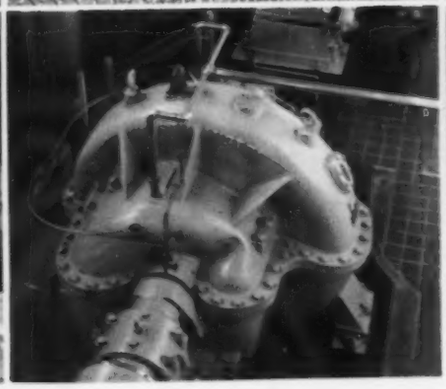
Makers of: Homestead Ball Valves, Cam-Seald, Lever-Seald and Lubricated Plug Valves

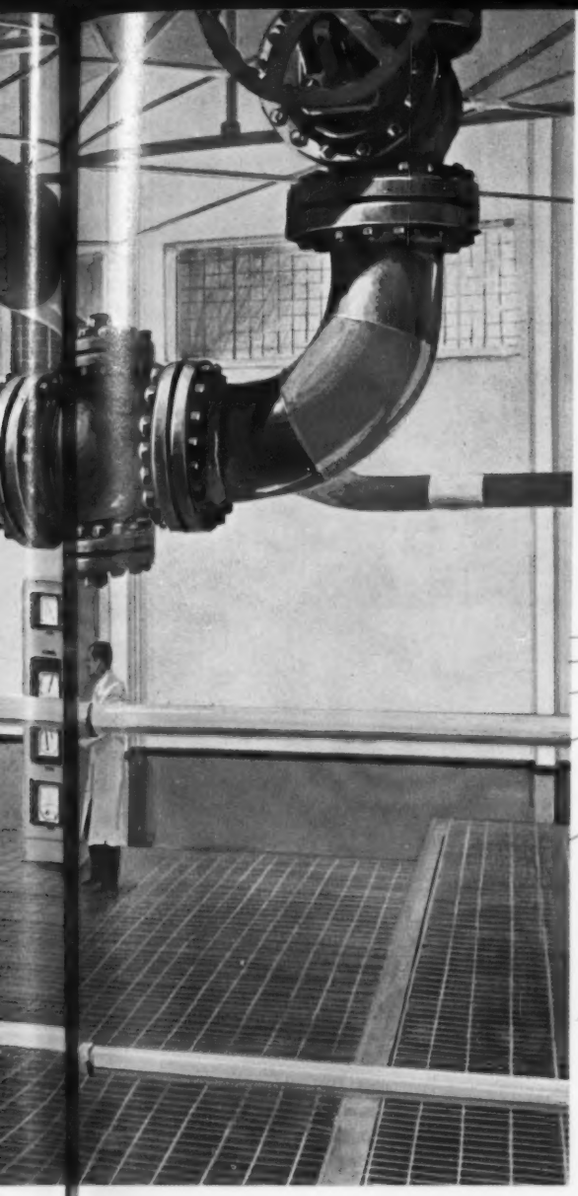












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NEW COLOR HORIZONS

System

HERE is a modern, functional *system* that combines four important points. (1) the ability to stop rust, (2) modern color harmony, (3) durability to last and last, (4) ease of application. From machinery, equipment, and structural steel to tanks, steel fences and metal sash – the Rust-Oleum New Color Horizons System can provide lasting beauty in the colors of your choice. Ask your Rust-Oleum Industrial Distributor, together with your Rust-Oleum Factory Specialist, to make a survey of your plant and provide complete recommendations. Rust-Oleum Industrial Distributors maintain complete stocks for prompt delivery in all principal cities of the United States, Canada, and in many countries around the world.

Rust-Oleum, in its various forms, can also save you time and money on problems like these: Heat Resistance, Water Resistance, Chemical Resistance, Coating Galvanized Metal, Speedy-Dry Coatings (less than thirty minutes to dry).

PROVED THROUGHOUT INDUSTRY FOR OVER THIRTY-FIVE YEARS

RUST-OLEUM®

See our catalog in Sweet's.

STOP RUST by applying Rust-Oleum 769 Damp-Proof Red Primer directly over the sound rusted surface

Save time, money, and metal. Brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining sound rusted surface after scraping and wirebrushing to remove rust scale and loose rust. **Specially-processed** fish oil vehicle penetrates rust to bare metal as proved in radioactive tracing studies.

STOPS RUST!®

Distinctive as your own fingerprint. There are imitations, but only one Rust-Oleum.

Insist upon industry-proved Rust-Oleum. Accept no substitute.

You take the brush! Try a free test sample!

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2985 Oakton Street • Evanston, Illinois

At no cost or obligation, please send me:

- ☐ New full-color catalog on New Color Horizons System and specialized Rust-Oleum systems, including color charts and applications.
- ☐ FREE TEST SAMPLE of Rust-Oleum 769 Damp-Proof Red Primer.
- ☐ Please have your representative contact us to discuss a plant survey.

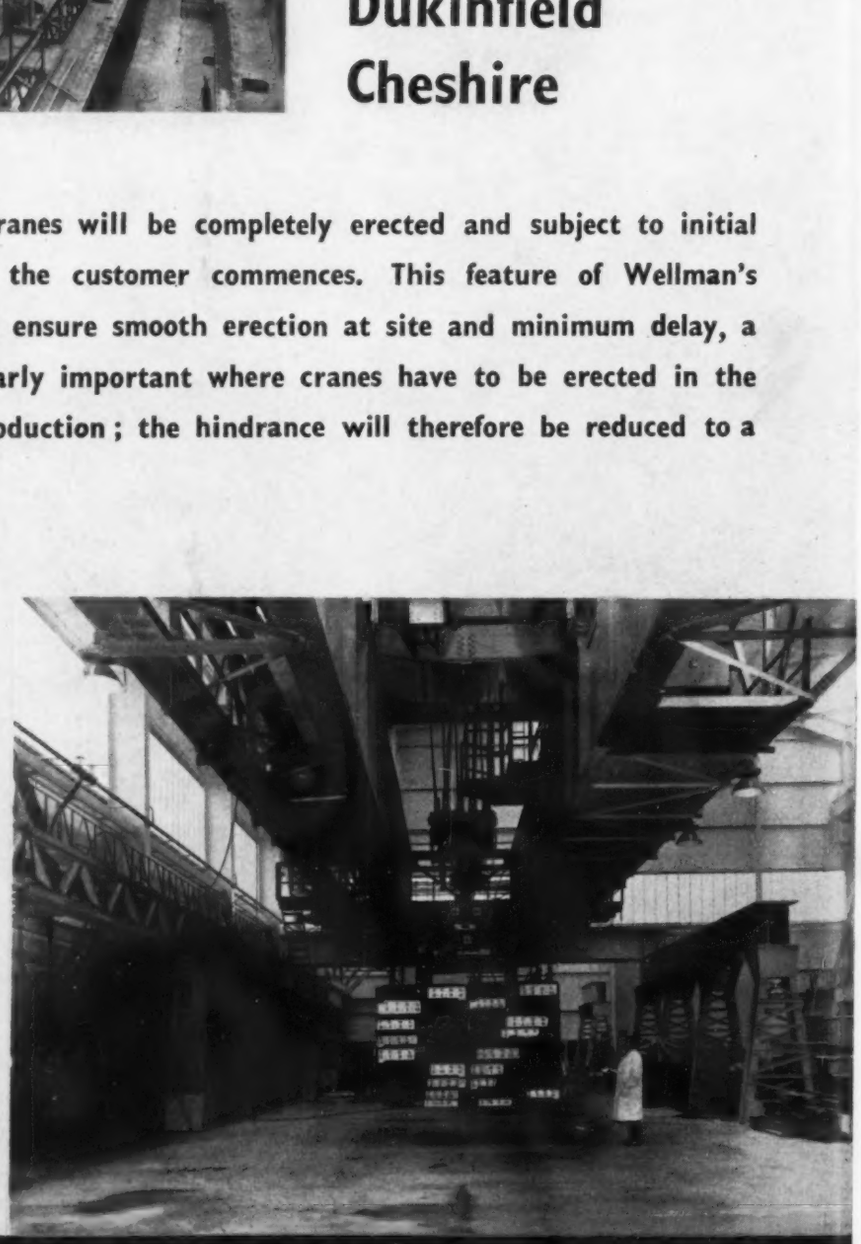
Wellman

announce the completion of their new Crane Erection Shop at their

Globe Lane Works
Dukinfield
Cheshire

In future all Wellman Cranes will be completely erected and subject to initial tests before delivery to the customer commences. This feature of Wellman's service to the client will ensure smooth erection at site and minimum delay, a feature which is particularly important where cranes have to be erected in the vicinity of continuing production; the hindrance will therefore be reduced to a bare minimum.

Our photograph reproduced by kind permission of Messrs. RICHARD THOMAS & BALDWINS LIMITED, shows the first of four 85 TON LADLE CRANES ordered from Wellman by Richard Thomas & Baldwins Ltd. for their important new works at Newport, Monmouthshire—successfully undergoing full load tests.



THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LTD.
PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1 WORKS: DARLASTON, South Staffs, & BELFAST.

Publication Service...

June, 1961

You Can Obtain . . .

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Note: Post cards expire three months after publication date.

(1) Metal-Clad Switchgear

A bulletin containing 42 pages with illustrations including charts and diagrams has been published by General Electric Co. This publication details versatility, system protection, safety, compactness, ease of maintenance and ease of ordering metal-clad switchgear. Features, installation data, dimensions and ratings for switchgear ranging from 2.4 to 13.8 kv and 75 to 1000 mva are provided. Typical basic equipment arrangements for use with generator and exciter, typical feeder, incoming line or transformer, induction motor full-voltage starting, synchronous motor full voltage, synchronous motor neutral reactor are discussed. (Bulletin GEA-5664F)

(2) Steel Strapping Tools

An illustrative, 16-page bulletin available from Acme Steel Co. describes the firm's complete line of powered steel strapping tools and accessories. Complimented by more than 35 applications photos and several attractive products-on-display panels, the two-color brochure offers pictorial examples of profitable product use by the shipping, packaging and materials handling industries. It features concise product data and specifications on powered tools as steelstrappers, stretchers, sealers, tool mounts, strap feed assemblies and strapping accessories. Advantages of various molds of these tools with their available power selections are also explained. (Booklet AD-300)

(3) Insulating Firebrick

Engineers, works managers and purchasing agents in a wide variety of industries will find valuable information in a 35-page bulletin released by the Babcock & Wilcox Co.'s Refractories division. This illustrated bulletin contains a complete discussion of the advantages of insulating firebrick, as well as charted information on a wide variety of applications. Also contained are drawings of insulating firebrick constructions, providing simple solutions to complex design problems and basic application and selection data such as heat loss and storage tables. (Bulletin R-38)

(4) Marking Devices

More than 200 marking tools, fixtures and automated machines are detailed in a 48-page catalog published by M. E. Cunningham Co. The hand tools range from a dozen styles of steel stamps, through more than twenty type holders. Also included are press type holders and many types of special application marking tools and partially and fully automated marking machines. (Catalog 300)

(5) Bearings

A 6-page folder on flex-block sleeve bearings is now available from Link-Belt Co. It announces two new types of self-alining and self-lubricating sleeve bearings in flanged and pillow block types that solve application problems of temperatures up to 1000 deg F; corrosive and contaminating conditions; under water operations; lubricating problems and where noise is a factor. The new bearings are self-alining, self-lubricating and are ideal for slow speed installations. (Folder 2823)

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1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

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51	AUTOMATIC TRANSPORTATION CO.		Heavy duty trucks
52	BABCOCK & WILCOX CO., THE	BULLETIN R-35A	Refractory castables
53	BLISS CO., E. W.	CATALOG 40B	Rolling mills
54	BROWNING & CO., INC., VICTOR R.		Cranes and trolleys
55	BROWNING & CO., INC., VICTOR R.		Crane brakes
56	BUSSMANN MFG. DIV., McGRAW-EDISON CO.	BULLETIN FIS	Dual-element fuses
57	BUSSMANN MFG. DIV., McGRAW-EDISON CO.	BULLETIN HCS	Hi-cap fuses
58	CLARK CONTROLLER CO., THE	BULLETIN 106-B	Magnetic brakes
59	CONE-DRIVE GEARS, DIV. MICHIGAN TOOL CO.	BULLETIN CD-218	Speed reducers
60	CORRECT-AIR CORP.	BULLETIN 2001-E	Crane conditioning
61	DURALOY CO., THE	BULLETIN G-159	High alloy castings
62	FARVAL DIV., EATON MFG. CO.	BULLETIN 26-T	Lubrication systems
63	EDERER ENGINEERING CO.	BULLETIN CR-610	Industrial cranes
64	ELWELL-PARKER ELECTRIC CO., THE		Fork and ram trucks
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72	GPE CONTROLS, INC.	BULLETIN EG84	Strip guides
73	HAGAN CHEMICALS & CONTROLS, INC.	BULLETIN MSP-163	Electronic controls
74	HOMESTEAD VALVE MFG. CO.	REFERENCE BOOK 39-1	Plug valves
75	HUNT VALVE CO.	BULLETIN 517	Descaling valves
76	JOHNS-MANVILLE CORP.	BOOK PK-131A	Mechanical packings
77	LINK-BELT CO.	BOOK 2707	Bearings
78	PLIBRICO CO.	LABORATORY REPORT 900-A	Refractory patching
79	POST-GLOVER ELECTRIC CO., THE	BULLETIN 500	Steel grid resistors
80	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN B-2515	Motor coolers
81	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN D-2508	Static drives
82	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN E-2409	Gear motors
83	SPRAYING SYSTEMS CO.	CATALOG 24	Spray nozzles
84	SQUARE D CO., EC&M DIV.	BULLETIN 8210	Motor starters
85	SYNTRON CO.	CATALOG 605	Complete product line
86	TAYLOR INSTRUMENT COS.	BULLETIN 98262	Potentiometer transmitters
87	WAGNER ELECTRIC CORP.	BULLETIN TU-152	Substations

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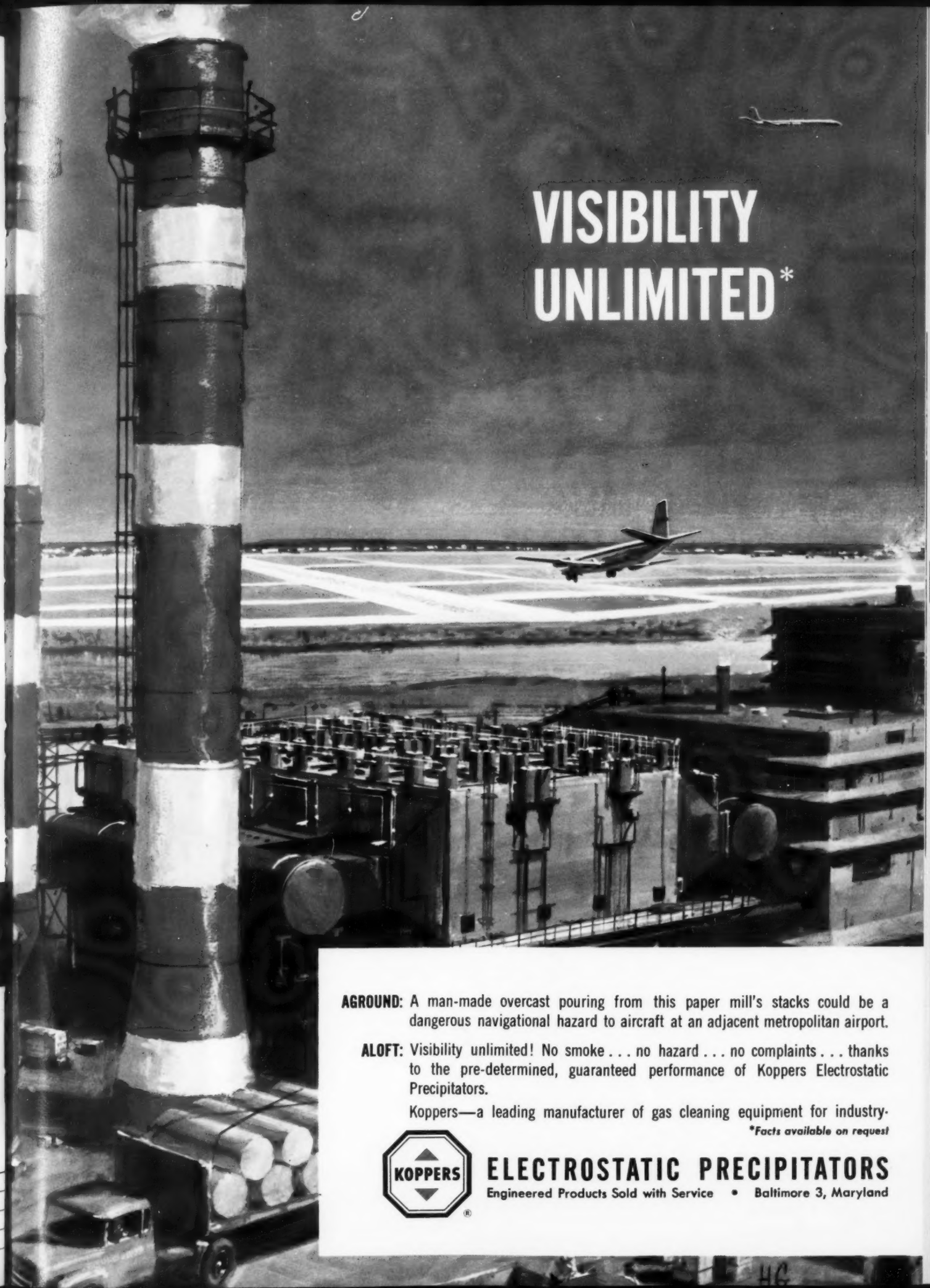

AGROUND: A man-made overcast pouring from this paper mill's stacks could be a dangerous navigational hazard to aircraft at an adjacent metropolitan airport.

ALOFT: Visibility unlimited! No smoke . . . no hazard . . . no complaints . . . thanks to the pre-determined, guaranteed performance of Koppers Electrostatic Precipitators.

Koppers—a leading manufacturer of gas cleaning equipment for industry.

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Two 75-ton Cranes built by Browning for heavy steel mill service

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Electric Overhead Traveling Cranes
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Browning cranes are designed and built specifically for heavy duty mill type and industrial service. Mill type cranes meet or exceed AISE requirements. We build into every crane whatever special features, mechanical or electrical, which you may desire.

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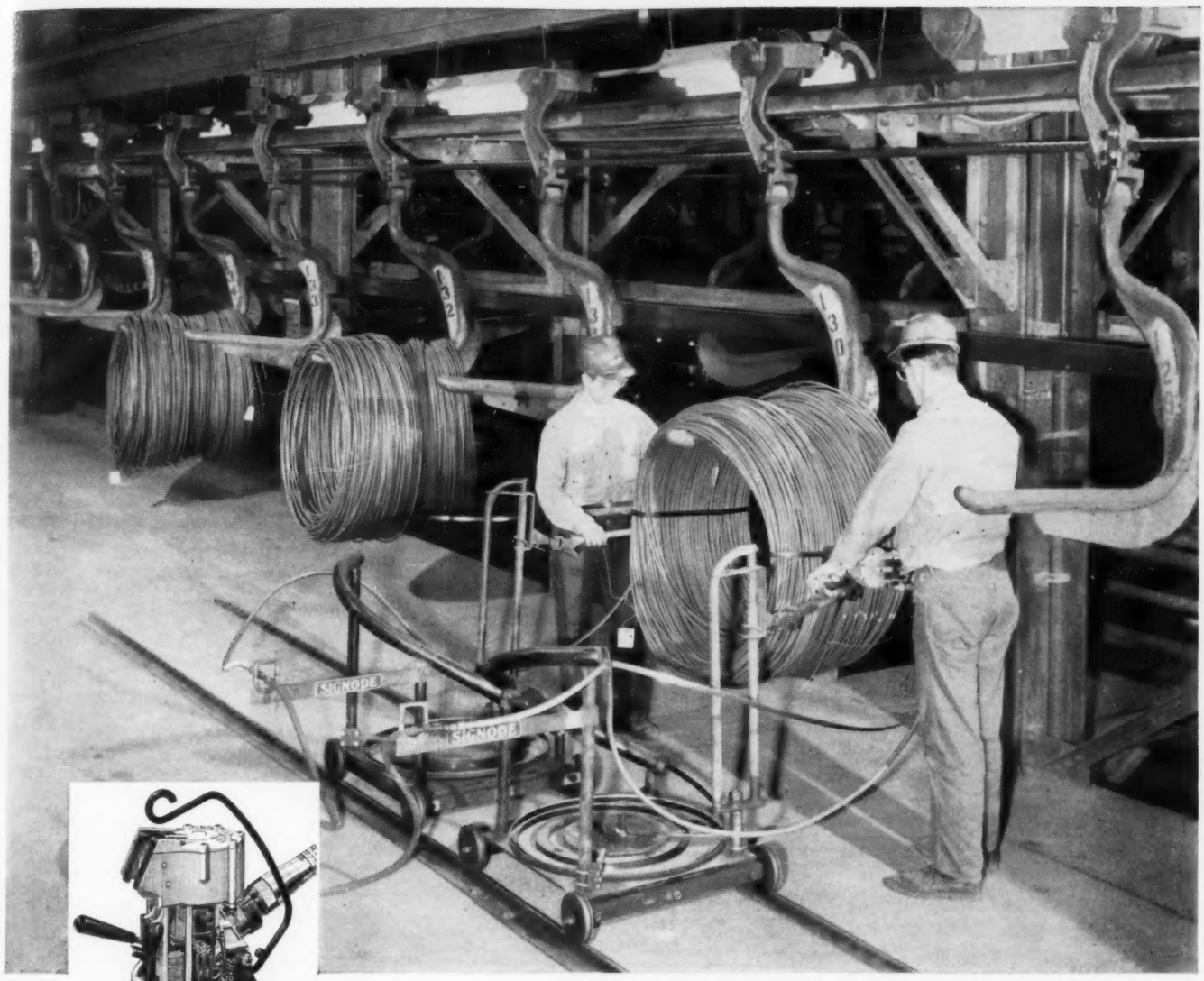

Bundle two 900-pound coils on moving conveyor in 30 seconds

Two operators—each using a Signode AMP all-power strapping tool and working in unison—put two steel straps around two 900-pound coils of green rod in 30 seconds!

This setup, which permits making full use of the speed of the AMP, was developed by the manufacturer. It incorporates a mobile strapping station that rolls on tracks paralleling the conveyor line. As the operators work, they move along with the conveyor hook that holds the two coils being strapped. When the strapping operation is completed, they move back to the starting point...30 seconds later. Coils are compressed 30% by the strapping.

The Signode AMP is compact, well-balanced, weighs only 22 pounds. Press a trigger and air power tensions the strapping; press another and air power seals and cuts off the strapping from the coil. The AMP uses new, easy-loading NESTACK seals, which come in nested stacks that eliminate waste and delay. The tool is available for ⅝″ and ¾″ strapping, .015″ to .035″ gauge. Special high-tension models are available.

Let us send you additional information on the Signode AMP tool, or, if you prefer, call the Signode man near you.

First in steel strapping

SIGNODE
STEEL STRAPPING CO.
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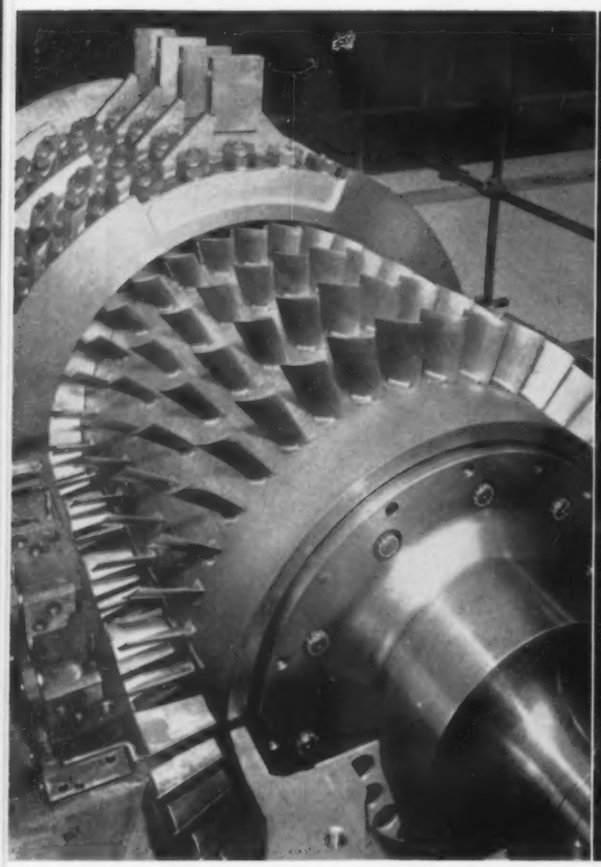
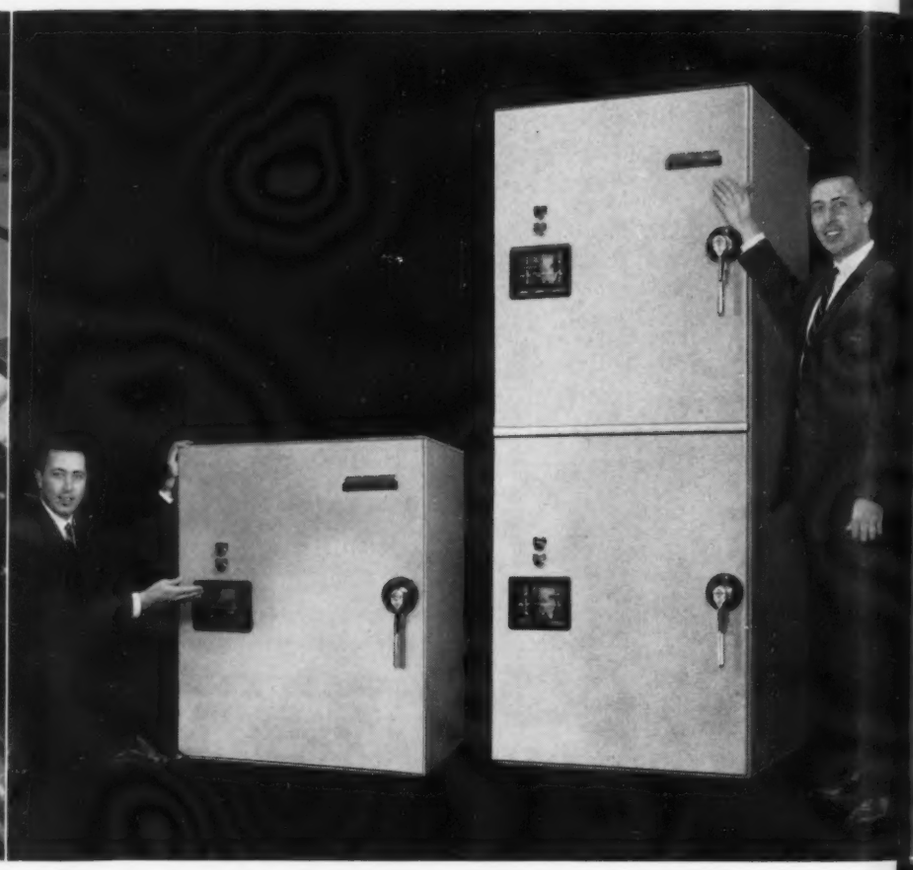


Fully adjustable stator blade control: Extends range of highly efficient axial compressors. Combines ability to meet fluctuating demands at constant speed with basic axial design advantages . . . steam savings of over 10%, and space and weight savings 25 to 50% of that required by comparable centrifugal compressors.



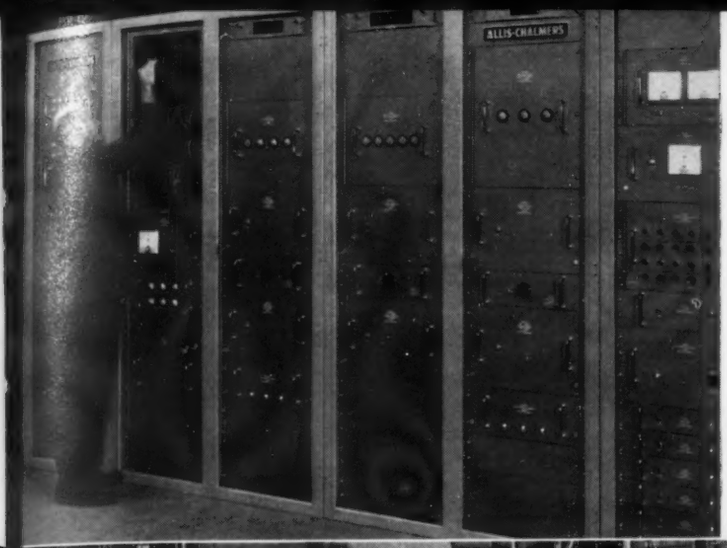
So low, two fit where one used to go: This new SpaceMaker control center is the first completely new 2- to 5-kv motor controller in more than a decade. Two-high design can cut floor space requirements in half. Complete drawout construction makes it the safest, most easily accessible controller on the market. New flame-retardent, track-resistant Super Pyro-Shield insulation adds to reliability, reduces size and weight. And, the all-new roll-out contactor is designed to cut maintenance time.

Which of these productive ideas could be working for you?

Screens that can't blind. Compressors with adjustable capacity at constant speed. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industrial Equipment Division, 900 S. 70th Street, Milwaukee 1, Wisconsin.

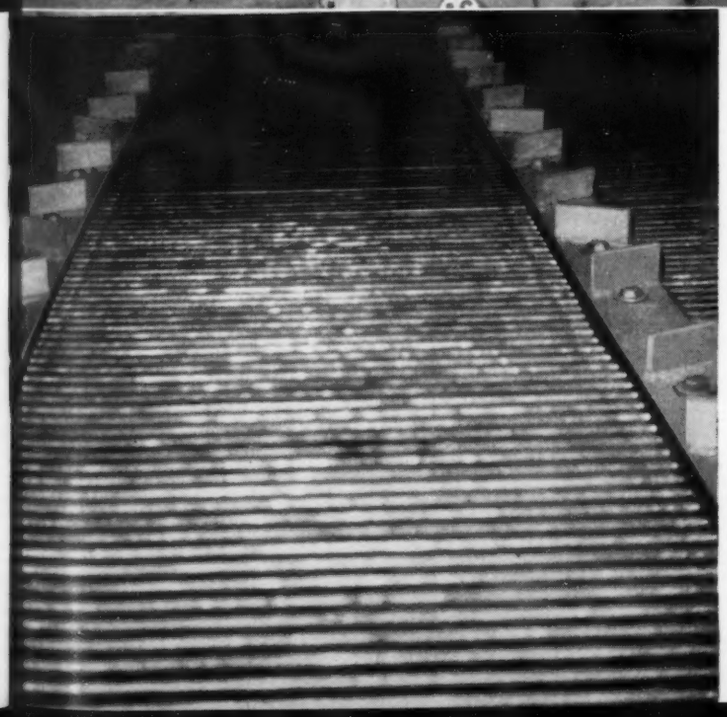
A-1399

Systemation is an Allis-Chalmers servicemark. *SpaceMaker* and *Pyro-Shield* are Allis-Chalmers trademarks.



For quality control . . . lower processing costs: Systemation engineers at Allis-Chalmers will undertake responsibility for the design of complete operating facilities. Systemation service is based on a thorough understanding of your processing requirements gained from years as a major equipment supplier to your industry. Added is the experience of over 500 successful advanced electronic control systems by Consolidated Systems Corporation, an affiliate company.

Sixty-eight motors power plating rolls: When this electrolytic tin line went into operation in 1960, 68 Allis-Chalmers totally-enclosed fan-cooled dc gearmotors powered the plating rolls. Additional Allis-Chalmers motors and supporting motor-generator sets provide power throughout the line. Whether small process line drives such as these, or huge main mill drives, A-C motors have earned a reputation for long life and trouble-free operation.

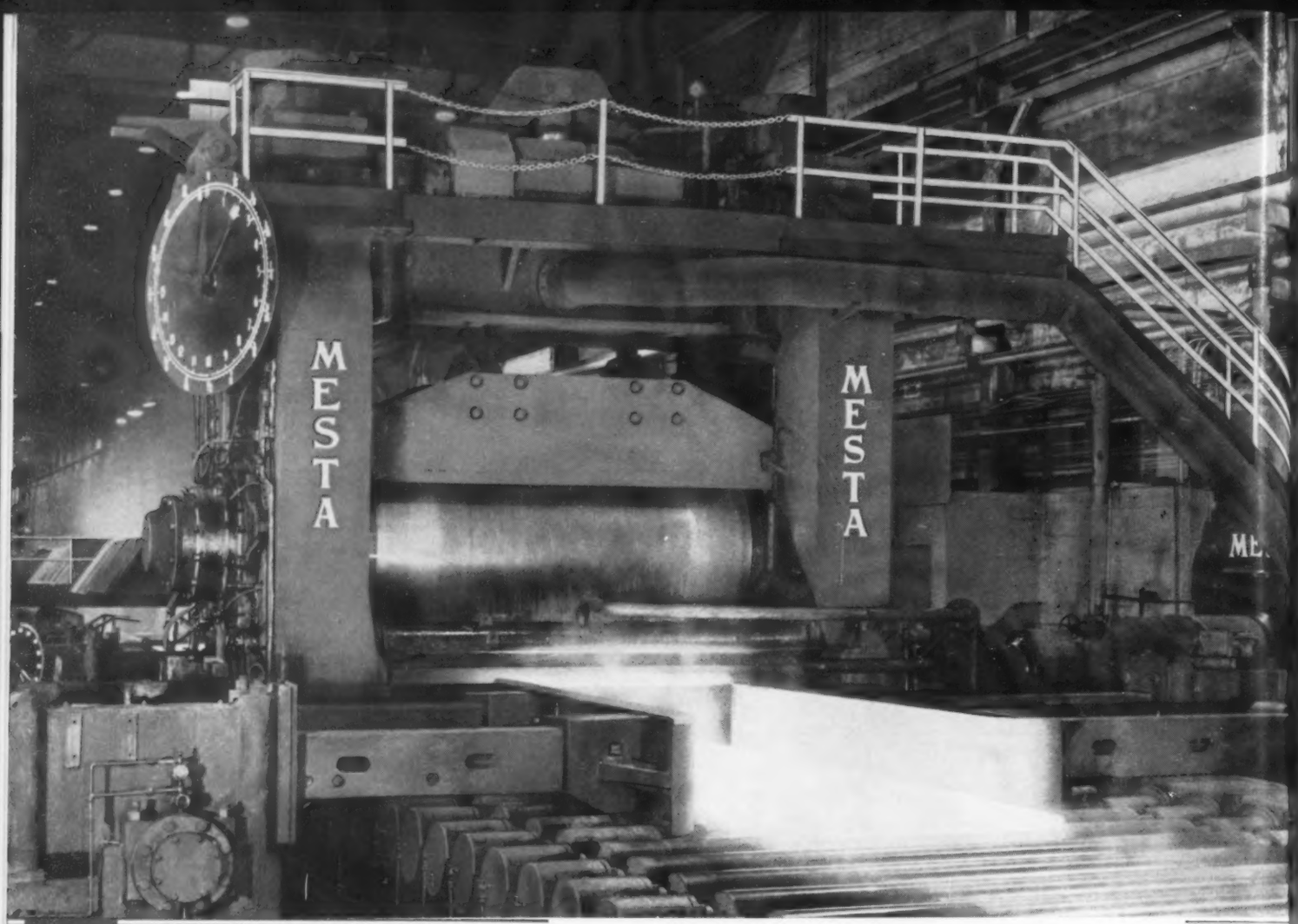


Screen moist, sticky ores without blinding: Allis-Chalmers new loose-rod deck for vibrating screens makes finer separations — down to ⅜ or ¼ in. — at increased capacity and improved efficiency. The rods roll and bounce, freeing themselves of sticky material. Similar cost-saving advantages are also found in A-C hot sinter screens and sizing screens.

A-C INDUSTRIAL EQUIPMENT DIVISION: motors, generators, controls, rectifiers, pumps, compressors, grinding mills, screens, industrial systems.

OTHER A-C PRODUCTS: thermal, hydro and atomic electrical generating equipment; switchgear, transformers, unit substations; tractors, earth-moving equipment, engines, lift trucks.

ALLIS-CHALMERS

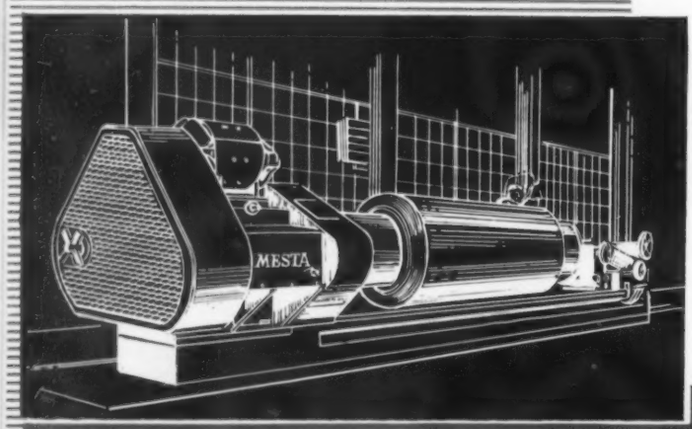


MESTA 148" Four-High Reversing Plate Mill
at Fontana Works of Kaiser Steel Corporation.

PLATE MILLS

designed and built by

MESTA



Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

Personnel News...

William A. Steele was elected chairman and president of Wheeling Steel Corp. Mr. Steele, who has been president and chief executive officer since 1958, succeeds **John L. Neudoerfer,** who retired April 30. Mr. Steele has been with Wheeling since 1943 and, prior to that, was associated with Crucible Steel Corp. of America. Mr. Neudoerfer had been with Wheeling and predecessor companies since 1907. He was elected vice president in charge of sales in 1931. In 1944 he was elected president of Wheeling Corrugating Co., principal subsidiary, in addition to his capacity as vice president of Wheeling Steel. In 1949, Mr. Neudoerfer was elected executive vice president and, in 1950, president of Wheeling Steel Corp. He had been chairman of the board since 1958. **Paul W. Koenemund,** vice president in charge of operations, was elected to Wheeling's board of directors.

R. W. Simon has been appointed vice president—metallurgy of United States Steel Corp., succeeding **L. J. Rohl** who retired April 30. Mr. Simon joined U. S. Steel in 1927 as a metallurgical assistant at Homestead district works. Later he advanced to various metallurgical and administrative positions at the Duquesne, Pa., and Youngstown, Ohio, Works. In 1935, after serving as assistant chief metallurgist at Youngstown, Mr. Simon was transferred to the Pittsburgh metallurgical staff. Four years later he was made assistant manager of the Pittsburgh district Metallurgical Division, and in 1942, manager of the division. He became assistant chief metallurgical engineer in 1947, and chief metallurgical engineer, operations—steel, the position he held prior to his present appointment, in 1954. Mr. Rohl joined U. S. Steel in 1917 at South Works, Chicago, and subsequently became assistant to the general superintendent in 1933. In 1947, he became chief metallurgical engineer, operations—steel, and in 1954, he was named chief metallurgical engineer of U. S. Steel. Two years later, he was appointed to this most recent position, vice president and chief metallurgical engineer. **Charles J. Hunter** succeeds Mr. Simon as chief metallurgical engineer of operations—steel. Mr. Hunter had been general superintendent since 1956 of the corporation's South Works, Chicago, Ill. **William E. Haskell** was named to succeed Mr. Hunter as general superintendent of South Works. Mr. Haskell had been assistant general superintendent at South Works since 1955. At the same time, it was announced that **Howard A. Parker** has been named to replace Mr. Haskell as assistant general superintendent, South Works.

W. R. Breeler, general manager of Allegheny Ludlum Steel Corp.'s plant at Dunkirk, N. Y., since 1945, has been named president of Allegheny Ludlum International, S. A., with headquarters in Geneva, Switzerland, effective July 1. **A. H. Hanks,** manager of the corporation's Watervliet, N. Y., works since 1952, has been named general manager—bar, wire and tube production. In his new capacity, Mr. Hanks will be responsible for the operation of both the Dunkirk and Watervliet plants.

Walter L. Saccani has been appointed assistant superintendent of the Open Hearth Department at Kaiser Steel Corp.'s Fontana plant. Mr. Saccani came to Kaiser in 1959 as general foreman, pits and auxiliaries, open hearth. He was assistant superintendent of basic oxygen steelmaking prior to his present appointment. From 1950–59 he was with the steel division of Ford Motor Co. as general foreman in the Open Hearth Department. Prior to that he was a process engineer for two years with Carnegie-Illinois Steel Corp. **C. L. French** was named to succeed Mr. Saccani as assistant superintendent of the Basic Oxygen Steelmaking Department. Mr. French has been associated with the Iron and Steel Division of the Plant Engineering Department since he joined the company in 1956. He started as a junior staff engineer and was named a staff engineer in 1957. Two years later he became senior staff engineer and was appointed to head the Iron and Steel Division of plant engineering earlier this year.

W. A. STEELE

R. W. SIMON

C. J. HUNTER

W. E. HASKELL

Leonard C. Rose was appointed executive vice president, and **Rudolph Smith,** executive vice president-operations, the Colorado Fuel and Iron Corp. Mr. Rose had been serving as director of purchases since 1947. He joined CF&I in Denver in 1929, and has held various positions within the corporation. Previously he had been associated with the Ford Motor Co. and Algoma Steel Corp. Mr. Smith had been serving as works manager of CF&I's Pueblo, Colo., plant since 1951. **Fordyce Coburn** succeeds Mr. Rose as director of purchases. Mr. Coburn joined CF&I in 1951 as district manager of the Birdsboro, Pa., and Wharton, N. J., operations. Prior to this, he had been associated with International Harvester and Brooke Iron Co. **C. Clay Crawford** has been appointed works manager of the Pueblo plant, succeeding Mr. Smith. Mr. Crawford had been serving as superintendent of the seamless tube mill since 1956. Previously he served as assistant superintendent of the seamless tube mill and in the quality control department. He joined CF&I in 1946 in the Mining Department at Pueblo. **Leo C. Hilt** has been appointed superintendent of the seamless tube mill succeeding Mr. Crawford. Mr. Hilt has been serving as assistant superintendent of the seamless tube mill since last December. Prior to this he was assistant superintendent of the seamless tube mill's hot mill. He joined CF&I in 1953 as general foreman of the hot mill. Prior to joining CF&I he was associated with National Tube Div., U. S. Steel Corp. in Gary, Ind., working as a seamless tube mill turn foreman.

J. W. Krasovich has been appointed division superintendent of the rail mill, 40-in. mill, rod mill and conditioning unit at the Colorado Fuel and Iron Corp.'s Pueblo plant. Mr. Krasovich had been serving as general foreman of the rod mill since 1949. Previously he had served as foreman and supervising inspector of the Inspection Department. He joined CF&I in 1925 in the 14-in. mill. **James E. Bowman, Jr.,** has been appointed general foreman of the rod mill, succeeding Mr. Krasovich. Mr. Bowman had been serving as assistant foreman for the rail mill, rod mill and conditioning unit since 1957. He had worked previously as turn foreman in the rod mill, production clerk in the rod mill, field timekeeper in the time office and in the shops office.

L. C. ROSE

RUDOLPH SMITH

FORDYCE COBURN

C. C. CRAWFORD

L. C. HILT

J. W. KRASOVICH

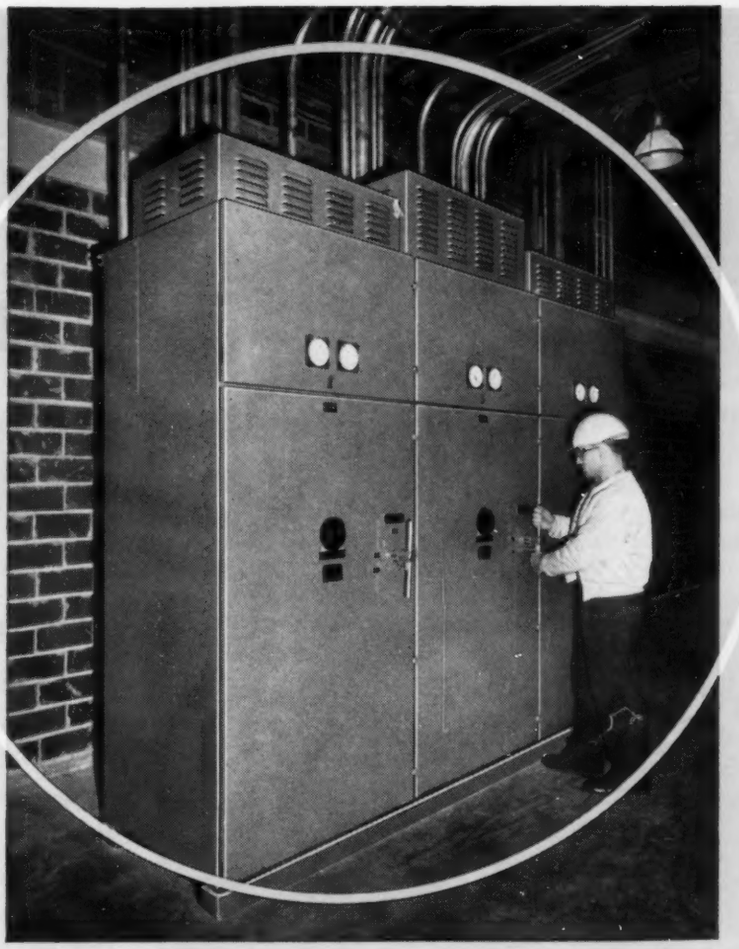
G. Findley Griffiths was elected president and chief executive officer of Acme Steel Co. **Guy T. Avery** remains as chairman until his retirement on November 1, but Mr. Griffiths assumes the duties of chief executive officer and will serve as chairman of the executive committee.

Donald C. Heidenburg has been appointed assistant superintendent in charge of the slabbing mill at Bethlehem Steel Co.'s Lackawanna, N. Y., plant. Mr. Heidenburg started work at the plant in 1950, and became a member of Bethlehem's loop training course in 1957. In 1959, he was made assistant to superintendent of the Mills Division, a post he had held until his current appointment.

Earl J. Moxley has been promoted from chief industrial engineer to operations engineer assigned to the staff of the general superintendent, Weirton Steel Co., division of National Steel Corp. **George D. Sission** succeeds Mr. Moxley as chief industrial engineer, Industrial Relations Department. At the same time, **Robert H. Miller,** formerly superintendent of mechanical shops, was named assistant to the manager of service and maintenance. Mr. Moxley was employed by Wheeling Steel Corp. from 1938 until 1955 when he joined Weirton as chief industrial engineer, holding that position until his current appointment. Mr. Sission was an industrial engineer for eight years with U. S. Steel Corp. before joining Weirton in 1958 as general supervisor, industrial engineering. He later was named assistant chief industrial engineer. Mr. Miller began his employment with Weirton in 1929 as a cost clerk and machinist apprentice in the steel works machine shop, and four years later became a machinist. In 1957, he was named superintendent of mechanical shops, holding that position until his current appointment.

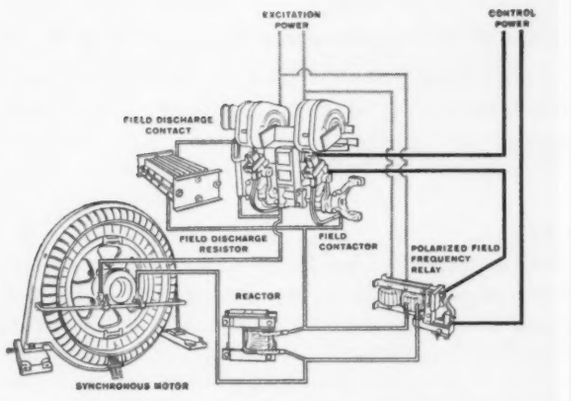
Robert H. Frazier was named manager of applied research, and **Joseph W. Lodge,** acting supervisor—

The Most Complete Synchronous Motor Protection you can buy!



- ***PUSH BUTTON START!***
- ***FULLY AUTOMATIC SYNCHRONIZATION!***

EC&M High Voltage Starters provide Simple, Safe Operation



POLARIZED FIELD FREQUENCY RELAY SYSTEM used in EC&M synchronous starters is noted for its simplicity, dependability, and for fast, positive synchronization at the most favorable time.

A push of the START button gives you complete motor protection, both starting and running—plus EC&M fully automatic synchronization! Motor windings are protected throughout the entire sequence. If the motor slows down, field excitation is automatically removed—the motor is permitted to re-accelerate—and resynchronization occurs automatically when the motor reaches the proper speed. Moreover, short circuit protection is available in both air and oil-break starters for any power system up to 5000 volts.

EC&M synchronous starters give the greatest motor protection plus the simplest operation and the easiest maintenance. They're available in ratings up to 4800 volts, with fuseless or fused interrupting capacity.

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wherever electricity is distributed and controlled

6329

LIFT A COIL, SCRAP, OR LADLE

40/15 ton, 120 ft. span Yuba Bedford Crane in sheet mill coil storage area at U.S. Steel's Gary Sheet and Tin Mill, Gary, Indiana.

. . . JOBS FOR YUBA BEDFORD CRANES

Move steel coils into storage, out for shipment – position and dump scrap–lift and "spot" huge ladles of molten steel... these are the jobs Yuba Bedford Cranes are designed to perform effortlessly, dependably and continuously.

Bedford Cranes have done the difficult and the heavy work for steel makers for over half a century. During periods of high plant capacity, Bedford Cranes work ceaselessly shift after shift, with only routine maintenance. During periods of reduced capacity, these same cranes, with only slight modification, have been assigned to handle a variety of load ranges and services.

Whether you're modernizing or expanding it will pay you to check out savings that may be realized from the installation of Yuba Bedford Cranes. Full information on request.

Yuba designs and builds all types of cranes, including bridge, unloading and material handling, gantry and semi-gantry, floating and jib cranes. Also derricks, hoists, and launching towers for defense ordnance.

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specialists in steel mill cranes and custom cranes of all types

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WILLIAM GALLAGHER

new product development, The Youngstown Sheet and Tube Co. Mr. Frazier has been with the company since 1958 as supervisor of tubular product research and chief of the Buckeye laboratory, and Mr. Lodge joined the company in 1960 as coordinator of research projects. Joining the research and development staff as supervisor of raw materials research is **Dr. Melvin C. Chang,** whose special field is extractive and chemical metallurgy. **Dr. Royston P. Morgan** has been named supervisor of physical metallurgy. In this position he will be in charge of the Buckeye laboratories and all laboratory investigations involving product improvement and new product development. **Dr. Johannes M. Uys** has been appointed supervisor of iron and steelmaking. His special field involves the improvement of blast furnace and open hearth practices, and investigative work on solidification and conversion of steel products. Named assistant supervisor of raw material research is **George H. Denton. James L. Bayer** has joined the staff as a research engineer in mineral petrography. **William R. Patterson** has been engaged as a research engineer in product research, with special work on high strength low alloy steel. **Henry J. Oberson** is engaged as a research engineer, assigned to special duties in the raw materials section under Dr. Chang.

Stewart S. Cort has been elected vice president, Bethlehem Steel Co., in charge of the company's Pacific Coast Division. He succeeds **H. Harrison Fuller,** who died April 22.

Walter L. Longnecker, former Cleveland District manager of operations, American Steel and Wire Division, U. S. Steel Corp., was appointed director, engineering and research, of the division's newly-created Engineering, Research and Product Development Department. In the new department, **Floyd A. Garman** will continue to supervise engineering activities as chief engineer. **Walter O. Everling,** who has been director of research, becomes research consultant, and will assist in coordinating the activities of the three branches. **Ronald E. Griffiths,** who has been assistant director of research, was named to direct product development. **Dr. Raymond B. Hoxeng** was appointed director of research, succeeding Mr. Everling. Dr. Hoxeng had been assistant to director of U. S. Steel's applied research laboratory at Monroeville, Pa.

Robert H. Etnyre has been appointed works manager of the Houston, Texas, plant, National Supply Division, Armco Steel Corp. He succeeds **George S. Leonard,** who resigned. **John O. Miller** has been named works manager at National Supply's Gainesville, Texas, plant, succeeding Mr. Etnyre. **Russell A. Priest** will succeed Mr. Miller as chief industrial engineer at Gainesville.

William Gallagher was promoted to plant industrial engineer and **Ray Clifford** to assistant plant industrial engineer at Weirton Steel Co., division of National Steel Corp. Mr. Gallagher joined U. S. Steel Corp. as an industrial engineer in 1951 and remained there until 1959 when he joined Weirton as general supervisor—incentives in the Industrial Engineering Department, holding that position until his current appointment. Mr. Clifford began his employment with Weirton in 1958 as an industrial engineer, and in 1959 was named general supervisor—basic standards, Industrial Engineering Department, the position he held at the time of his current appointment.

W. Neel Robertson was named assistant to the sales manager of the Engineering Division, Hauck Manufacturing Co. Prior to joining Hauck, Mr. Robertson was associated with Holcroft & Co., and the Industrial Furnace Division of Sunbeam Corp.

J. Roy Barefoot has been named executive vice president, McKay Machine Co. and **Ralph N. Leitzell,** vice president and treasurer. **D. M. Davis,** formerly vice president and treasurer, was appointed vice president, in charge of special projects.

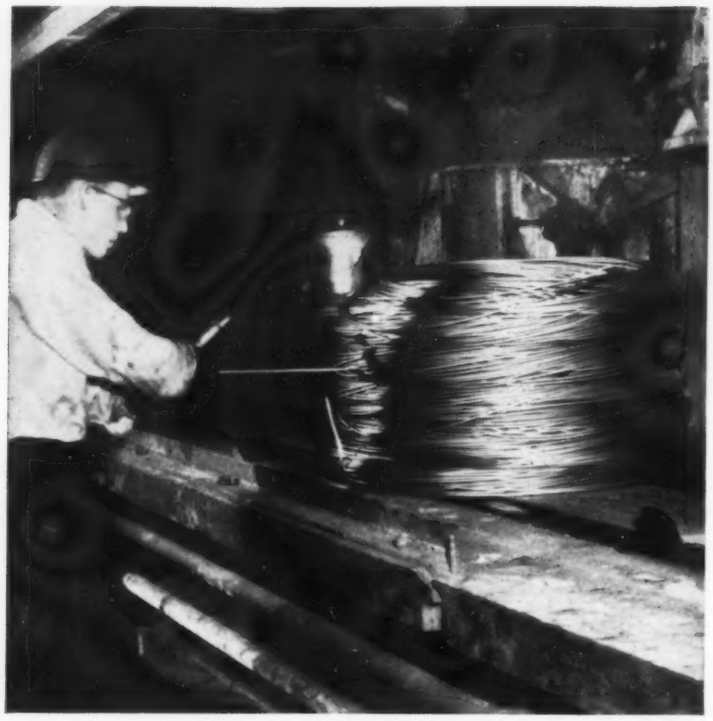
C. R. Montgomery has been appointed vice president in charge of research and technical services, Pittston Clinchfield Coal Sales Corp. Mr. Montgomery started

J. R. BAREFOOT

C. R. MONTGOMERY

REX®

helps a giant keep a "mile-a-minute" pace



Rex Coil Conveyor Chain used at Cuyahoga Works, American Steel and Wire Division, United States Steel Corporation

Rex Rod Coil Conveyor Chains were selected by Morgan Construction Company of Worcester, Mass., to help this giant four strand "rod mill of the century" keep a mile-a-minute production pace on the lines shown here.

The job: carrying steel rod coils, up to 1000 pounds, down two production lines, each having two conveyor groups...one group 330 feet long; the other, 252 feet long.

Specifications required chain with a carefully balanced combination of strength, wear life and economy. Rex Engineers, with 70 years of chain design, manufacturing and application experience coupled with modern research and quality control, delivered the goods! Rugged Rex 3557 Coil Conveyor Chain, shown at work above, was the answer.

Why not ask Rex Engineers to help you with planning and replacement problems.

Write CHAIN Belt Company, 4693 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: Rex Chainbelt (Canada) Ltd., Toronto and Montreal.

REX®

CHAIN BELT COMPANY

H. H. GORRIE

L. F. RICHARDSON

J. H. DENNIS

E. M. NEWTON

his industrial career in 1935 as an engineer in the Technical Department of Koppers Co., Inc. In 1941 he joined Monnesson Coke and Chemical Co. as chief chemist. Later he joined the By-Product Coke Department of Pittsburgh Steel Co. In 1949 he was promoted to technical assistant in the Blast Furnace Department of Pittsburgh Steel. In 1953, Mr. Montgomery joined the Pittston Co. as consulting engineer, and later was transferred to Pittston Clinchfield Coal Sales as carbonization engineer.

Frank T. Hickenlooper has been named general superintendent, Provo pipe mill, Consolidated Western Steel Division, U. S. Steel Corp. He was formerly plant engineer.

H. H. Gorrie has been elected executive vice president, Bailey Meter Co. At the same time, **L. F. Richardson,** was named vice president in charge of sales activities and a member of the board of directors, and **J. H. Dennis,** vice president in charge of all manufacturing activities and plants. Mr. Gorrie joined Bailey as a cadet engineer in 1927. In 1943 he was named head of the Design Department, appointed assistant chief engineer the following year, and chief engineer in 1953. In 1955, he was elected a vice president, and in 1957 elected a director. Mr. Richardson joined the company as a cadet engineer in 1930. In 1933, he was assigned to Los Angeles, Calif., as resident engineer, and in 1942 was named manager of the district. He was appointed sales manager of district operations in 1957. Mr. Dennis joined Bailey as a cadet engineer in 1937. He worked in the Pittsburgh district, and prior to 1946 was in the contract engineering and sales departments. From 1946 to 1954 he served as assistant director of the Education Department, and in 1954 was appointed manager of industrial relations. In 1960, he was named manager of manufacturing.

Emery M. Newton has joined Gas Atmospheres, Inc., as sales manager. He will supervise and control all sales activities of the company. Mr. Newton came to Gas Atmospheres from the Pure Carbonic Division of Air Reduction, Inc.

W. Arthur Gneiser has returned to Detroit, Mich., as manager of the Leeds & Northrup Co. office, succeeding **F. Dean Burnett,** who has retired.

Harold E. Imes was appointed president of Semet-Solvay Division, Allied Chemical Corp. He succeeds **Albert E. Scherm** who is retiring after 20 years of service as president of the Division.

John H. Sprow, formerly director of sales, Kane and Roach, Inc., is now president of Rolling Mills, Inc. The company has been newly-formed by Mr. Sprow for the design and manufacture of mill equipment.

Obituaries

H. Harrison Fuller, vice president of Bethlehem Steel Co., and in charge of the firm's West Coast steel operations since 1944, died April 22.

Oscar H. Jung, founder and president of the Trico Fuse Mfg. Co., died May 5. He was 76.

$2,500,000 INSTALLATION
STEEL SMELTING PLANT
FOR SALE
AT FRACTION OF COST

COMPLETE LOW & MEDIUM CARBON FERRO CHROME ALLOY STEEL SMELTING PLANT, WITH

FURNACES, 4—8,000 KVA, PITTSBURGH LECTROMELT 10½' DIAMETER, EQUIPPED WITH BATCH MIX SYSTEM & MILLING SYSTEM.

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90 West Broadway, New York 7, N. Y.
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for a mill that can roll back your cost barrier...

ENGINEERING

COUNSEL

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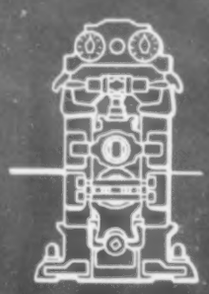
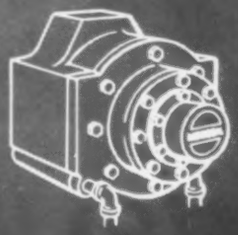
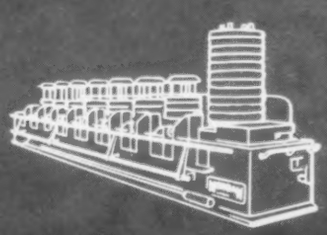


ROLLING MILLS



MORGOIL BEARINGS



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MORGAN has the take-charge team of design and construction specialists

START UP

ERECTION

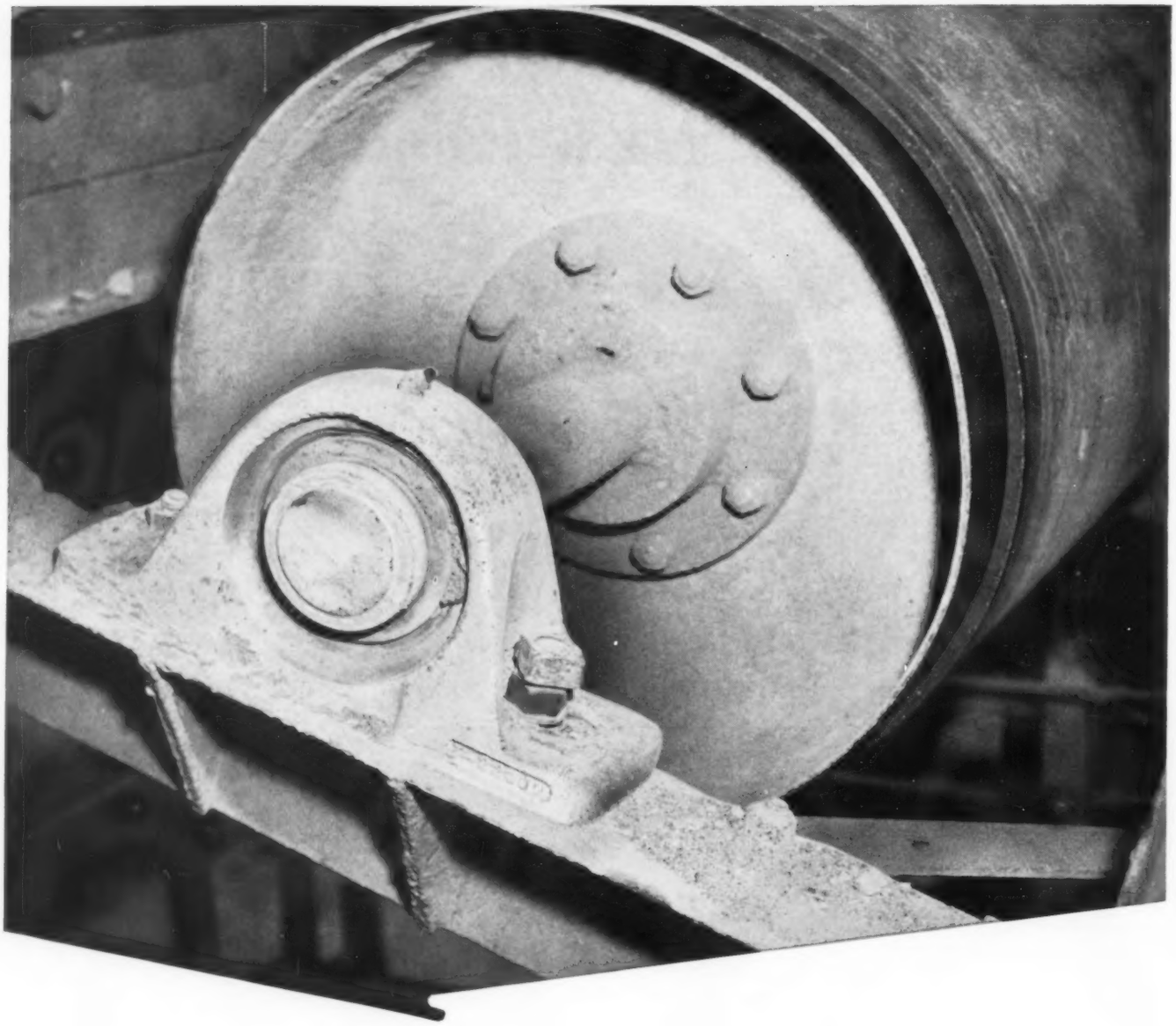
Long before foundations go in — long after "design" tonnage is reached — Morgan skills and experience are hard at work to protect profitability in your mill. They smooth the way at every stage of construction with an unmatched depth of technical support; provide tangible savings for every production "turn" with an unparalleled backlog of field-tested mill knowledge. How advantageously this affects operating statements is shown by the impressive list of reorders from Morgan mills round the world.

Steel

MORGAN WORCESTER

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

THE KEY NAME FOR PROGRESS IN STEEL-MAKING EQUIPMENT



The right seals on this bearing, and service life was increased 4 times!

This conveyor belt carries wet sand. The water and sand penetrated the felt seals of the bearings and caused frequent bearing failure. Our bearing engineers were consulted and their solution was a pillow block with neoprene plyaseals. Now after more than a year of operation, our customer reports service life of the bearings has increased four times.

This is just another example of the kind of service our bearing sales engineers give their customers. We try to get the right bearings in the right application and if the result is a saving on bearing purchases — that's fine with us. Our growth over the years proves that the more we save a customer, the more he buys. We'd like to help you save on bearing purchases — Call the branch nearest you!

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Assured Reliability due to:

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- Hi temp cured TEFLON-covered coils.

Panalarm maintains a large staff of annunciator engineering specialists to assist with special annunciator design and application problems. Sales and engineering offices are in all principal cities. Your inquiry will receive prompt attention.

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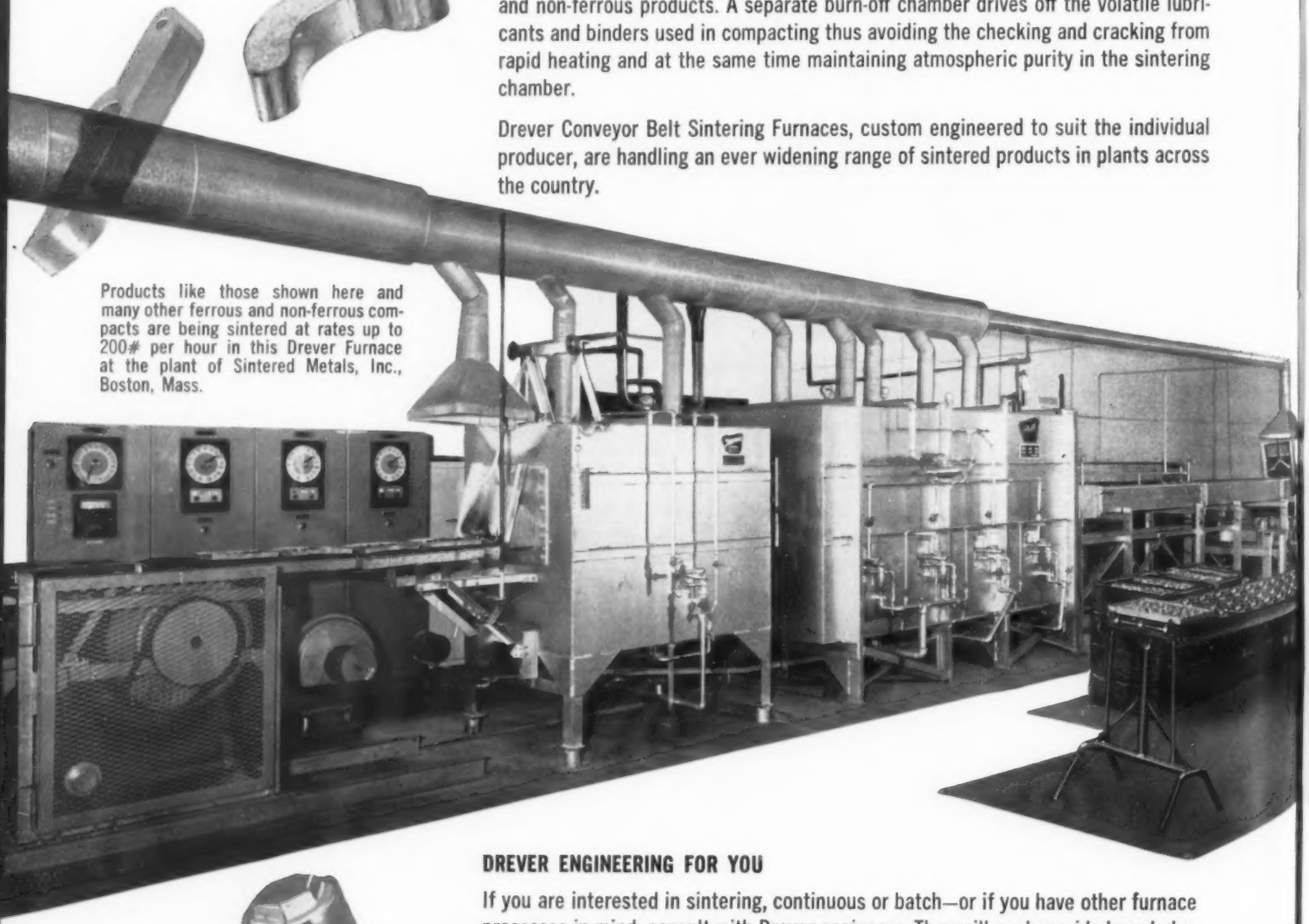
GEARS, KNOBS, TRIGGERS....

—AND A HOST OF OTHER POWDERED METAL PRODUCTS ARE CONTINUOUSLY PROCESSED IN CUSTOM ENGINEERED

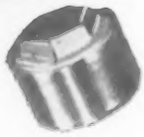
DREVER SINTERING FURNACES

Sintering, the all important final step in producing metal products from compacted powder requires critical control of temperature and atmosphere if superior finish and dimensional stability are to be achieved. Drever Conveyor Belt Sintering Furnaces provide such control in continuous operation accommodating both ferrous and non-ferrous products. A separate burn-off chamber drives off the volatile lubricants and binders used in compacting thus avoiding the checking and cracking from rapid heating and at the same time maintaining atmospheric purity in the sintering chamber.

Drever Conveyor Belt Sintering Furnaces, custom engineered to suit the individual producer, are handling an ever widening range of sintered products in plants across the country.



Products like those shown here and many other ferrous and non-ferrous compacts are being sintered at rates up to 200# per hour in this Drever Furnace at the plant of Sintered Metals, Inc., Boston, Mass.



DREVER ENGINEERING FOR YOU

If you are interested in sintering, continuous or batch—or if you have other furnace processes in mind, consult with Drever engineers. They will apply a wide knowledge of the latest developments backed by long furnace engineering experience. Write or phone us. Drever Company, Bethayres, Pa. Phone: Wilson 7-3400.

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ENGINEERING AND MANUFACTURING FACILITIES AROUND THE WORLD THROUGH ASSOCIATES IN FRANCE, GREAT BRITAIN, GERMANY, ITALY, JAPAN AND INDIA

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Call Ma Ma*

Anticipate your parts problems! Let MA MA bid the next time! MA MA builds original parts, replacement parts and accessories for Mill-Type equipment. In fact . . . when it comes to building equipment there isn't much that MA MA can't do! Let MA MA bid . . . you'll be pleased to find out how thrifty we are with your money and how fast we are with delivery.

***MA MA is an easy name to remember. It stands for MAchinery-MAintenance Division, Coronado Steel Company. MA MA's phone number is 747-4436.**

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FOR YOUR VERY OWN PANIC BUTTON FILL IN THIS COUPON TODAY! (Button has self-stick backing and will fasten on any surface.)

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Company_____

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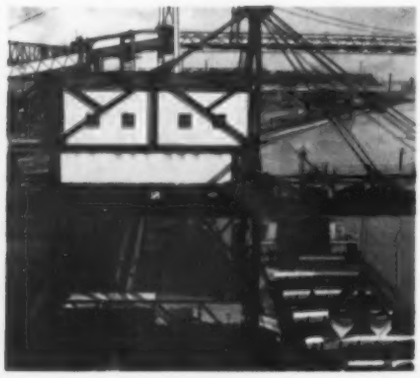
Dept. B

How Dravo serves the steel industry

MATERIALS HANDLING EQUIPMENT

New 1650-ton-per-hour unloader and a companion ore bridge rated at 1360 tph speed ore handling for midwest steel producer. Check the coupon at right for details on Dravo bulk materials handling equipment for mills, plants or docks.



ORE PROCESSING

Over 45% of sinter capacity added by U.S. steel industry in last 5 years has been furnished by Dravo—including this 2400-ton-per-day plant. Check and mail coupon to obtain more information on sintering, briquetting, pelletizing and ore beneficiating plants.

SPECIAL CONSTRUCTION

Head frame (left foreground of photo) sits astride 575-ft. concrete-lined ventilating shaft at a steel company mine. Construction of shafts, slopes, tunnels, docks and harbors are part of Dravo's half century of experience in special construction. Mail coupon for information.

PLANT

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Dravo furnished ore unloader, ore bridge and sinter plant for this midwestern steel producer.

PLANT UTILITIES

When completed, this modern intake and pumping station will handle up to 30 million gallons of water daily. Such Dravo turn-key projects include oxygen, power and boiler plants, compressor stations, other special utility and plant facilities. Mail coupon for information.

SPACE HEATING

One of 60 Dravo space heaters which supply comfort heating in this large strip mill. Over 20,000 units (¼ to 3 million btu) are in use throughout industry for all types of manufacturing and warehousing structures. Check and mail coupon for details.

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☐ Oxygen Plants
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☐ Container Cranes
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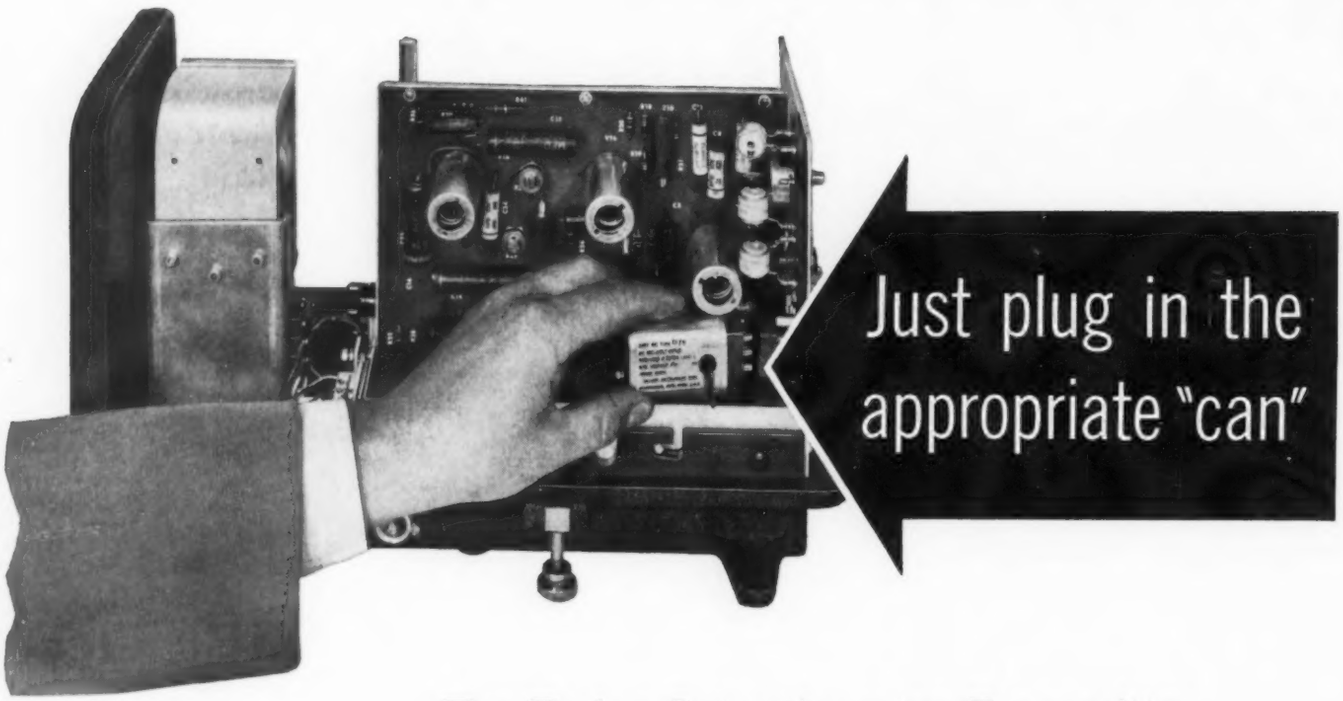
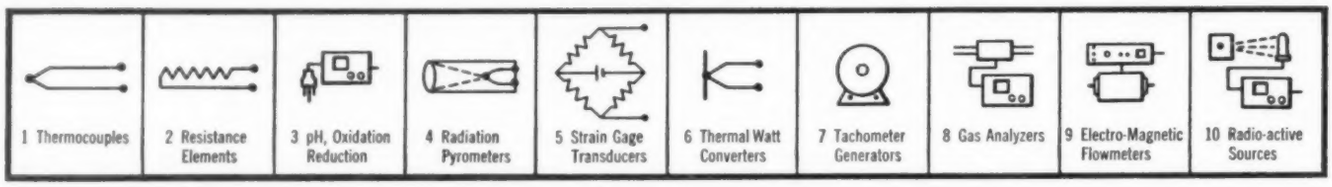
DRAVO



. . . The Taylor Potentiometer Transmitter will receive signals from all these sensing elements



Designed to convert low voltage measurement signals (millivolts) to an electric and/or pneumatic output for controllers and receivers, the 700T Potentiometer Transmitter is exceptionally adaptable. Plug-in service "cans" mean that the instrument can be quickly converted for use with different primary elements by simply inserting an appropriate can. For thermocouple applications, reference junction compensation is always correct since it is part of the can.

The 700T Transmitter comprises two basic units — an Electronic Potentiometer Amplifier, the output from which may be transmitted to data processing or other electrically-actuated equipment; and an Electro-Pneumatic Transducer which converts dc current to a proportional air pressure. This output air signal can then be used with pneumatic measuring and controlling instruments. Both amplifier and transducer plug in—a great convenience, as well as a big saving on instrument down-time. The same amplifier is used with all sensing elements, minimizing inventories.

For processes requiring pneumatic receivers and controllers, and applications using miniature instrumentation, the 700T Potentiometer Transmitter is ideally suited. Ask your Taylor Field Engineer for detailed information, or write for **Bulletin 98262.** Taylor Instrument Companies, Rochester, New York, or Toronto, Ontario.

Taylor Instruments **MEAN ACCURACY FIRST**

Operation: Descaling

(One of a series)

Drawn and annealed wire descaled
up to 800 feet per minute

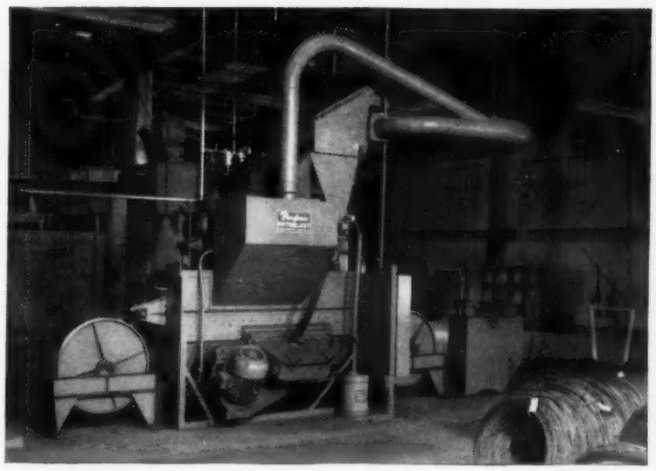
Hot rolled rod descaled
at 200-600 feet per minute

These figures speak for themselves!

Compare these speeds with your own descaling performance. Then consider this: fast descaling time is only one of many reasons why Pangborn Rotoblast cuts your costs.

Here are some other specifics: Rotoblast eliminates loss of virgin metal . . . ends acid disposal problems . . . requires less space . . . reduces original investment by as much as 70% over pickling equipment. Rotoblast descaling equipment goes to work at the touch of a button. Because it is a dry process, it is absolutely non-toxic, an important aid to employee morale. Rotoblasting gives an improved surface for application of lubricant.

You save money other ways, too. You can maintain Rotoblast more easily. Because Rotoblast Cabinets are fully lined with wear plates, you never have to replace the cabinets themselves. All three wheels of the Rotoblast units assembly are fully exposed and easily accessible—not locked up inside the equipment. Overall result: lower operating costs, lower maintenance costs.



Pangborn
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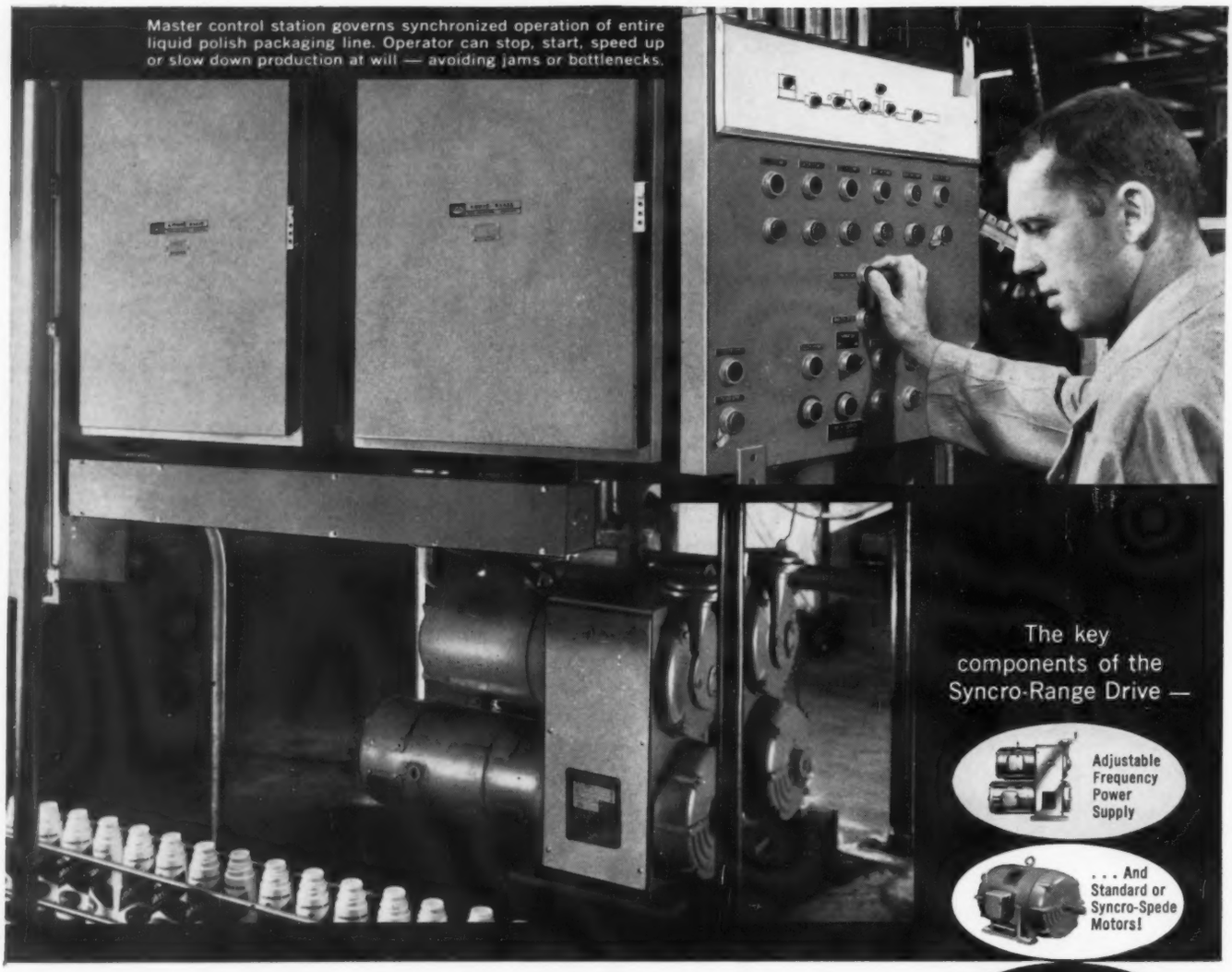
For more detailed information, write: PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Md.; Pangborn Canada, Ltd., 47 Shaft Rd., Toronto (Rexdale), Canada—*Manufacturers of Blast Cleaning, Vibratory Finishing, Dust Control Equipment; Rotoblast® Steel Shot and Grit℗.*


Master control station governs synchronized operation of entire liquid polish packaging line. Operator can stop, start, speed up or slow down production at will — avoiding jams or bottlenecks.
The key components of the Syncro-Range Drive —
Adjustable Frequency Power Supply
. . . And Standard or Syncro-Spede Motors!

LOUIS ALLIS SYNCRO-RANGE DRIVES automate liquid polish lines

Johnson's Wax, renowned wax and polish producer, uses Syncro-Range Drives for exact control of process lines

Controlling the speed of the precise, mass-production lines for their new, highly successful liquid shoe polish was the task Louis Allis engineers had to solve for Johnson's Wax.

The problem was to time the flow of plastic bottles, liquid polish, wool daubers, and caps into the packaging lines at precisely equal rates. Flow rate must be adjustable so the lines can be slowed down or speeded up. And the entire packaging operation must be controllable from a single master control. The Louis Allis Syncro-Range Drive solved the problem.

Syncro-Range Drive provides synchronized speed of any number of motors from a single control. It is a "packaged system" comprising an adjustable frequency power supply operating on 3 phase, 60 cycle power input . . . a group of Syncro-Spede® synchronous motors which maintain exact synchronism regardless of varying load . . . and a control which permits the speed of the entire group of motors to be simply adjusted without losing synchronization. On applications for which exact synchronism is not required, standard squirrel cage motors can be supplied.

You can readily see the advantages of the Syncro-Range Drive in systems or processes which require synchronized movement: multiple conveyors which feed consecutively; transfer lines; process lines; assembly lines requiring coordinated arrival of components; printing where one press feeds another; synthetic fibre spinning, drawing, or twisting; metal runout tables; and other similar machines which require the application of power at a number of points on the machine.

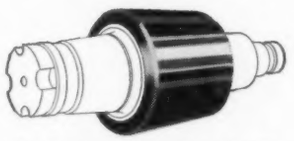
The Syncro-Range Drive is available with a choice of drive sizes to efficiently control from 2 to 200 motors. Control features are available to provide speed regulation accurate to 0.1% with 0% relative speed difference between motors! A trained Louis Allis motor application engineer is available to help. You can reach him at your local Louis Allis District Office, or by writing to The Louis Allis Company, 450 East Stewart Street, Milwaukee 1, Wisconsin.

ASD-232

LOUIS ALLIS

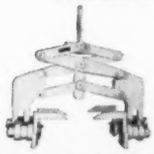
MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Heppenstall rolls it, cuts it, handles it



Back-up roll sleeves and rolls

Crop shear knives



Tongs—stock and custom designed

From melt shop to finished product, Heppenstall equipment plays an important part in modern steelmaking operations. Top-rate performance is provided by Heppenstall's back up roll sleeves and rolls—made from highest quality alloy steel, forged and heat treated to obtain maximum density, grain refinement and controlled hardness. Long on service is the industry-wide reputation of Heppenstall solid tool steel shear knives —for we use our own electric induction steels to assure maximum knife quality. If it has to be handled, Heppenstall tongs can help you. Regardless of shape, weight, or size, Heppenstall tongs can speed materials handling operations with greater efficiency and safety. For experienced Heppenstall service, or specific information, call our nearest Heppenstall Representative or write us direct.

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Plants: Pittsburgh & New Brighton, Pa. • Bridgeport, Conn.

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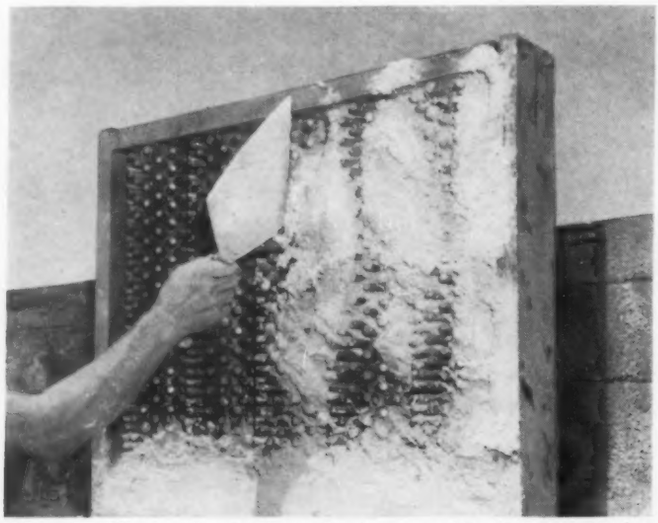
H
M H

Casting furnace linings in place can be speedily accomplished with any B&W Refractory Castable. Here, tough, erosion-resistant B&W Kaocrete-D is cast in a lining that will be ready for service soon after installation.

Gunning B&W Kromight-Gun assures complete penetration of irregular areas. This 3200 F refractory material is excellent for studded open hearth doors and similar metalworking installations.



Slap trowelling can be the most effective way of forming a vertical or overhanging section of lining, provided the castable has an exceptionally adhesive, plastic texture. B&W Kaocrete-B, possessing these properties, is widely used in this type of installation.

Vibrating B&W Kaocrete-32 in place to form center section of electric furnace roof. This method of installation provides density and strength, and eliminates laminations, air bubbles and pockets, thus permitting economical, long life.

How B&W refractory castables solve application problems

Installing refractory linings quickly and inexpensively is a major concern of furnace builders and operators. Each of the many different types of metal working furnaces presents its own particular installation problems. To meet these widely differing conditions, B&W offers not just one, but a range of *specialized* refractory castables. Each is *engineered* to provide savings in installation time. *Specialized* B&W Refractory Castables save money by eliminating the need for costly inventories of special shapes. The use of castables speeds up new construction and repair jobs and permits simplified, improved furnace design together with long life—in short, superior performance over a wide range of furnace operating conditions.

B&W Bulletin R-35A gives additional information on versatile B&W refractory castables. Write for copy to The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N. Y.

R621

B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

INTRODUCING

THE NEW DUAL HALLDEN SYNCHRONIZED *FLYING* PRESS AND SHEAR WITH INTEGRAL LEVELLER

- **Continuous Uniform Feed Directly from the Coil**
- **Open Construction for Easy Accessibility**
- **Unlimited Cut Length Range**

Latest Addition to the World Renowned Family of

HALLDEN FLYING CUTTING MACHINES

Equipped with micrometer adjustments for synchronization and feed while the machine is in motion.

Engineered and built to meet individual requirements for blanking, shape or square type cutting, or any combination —

Write for design survey of your specific requirements.

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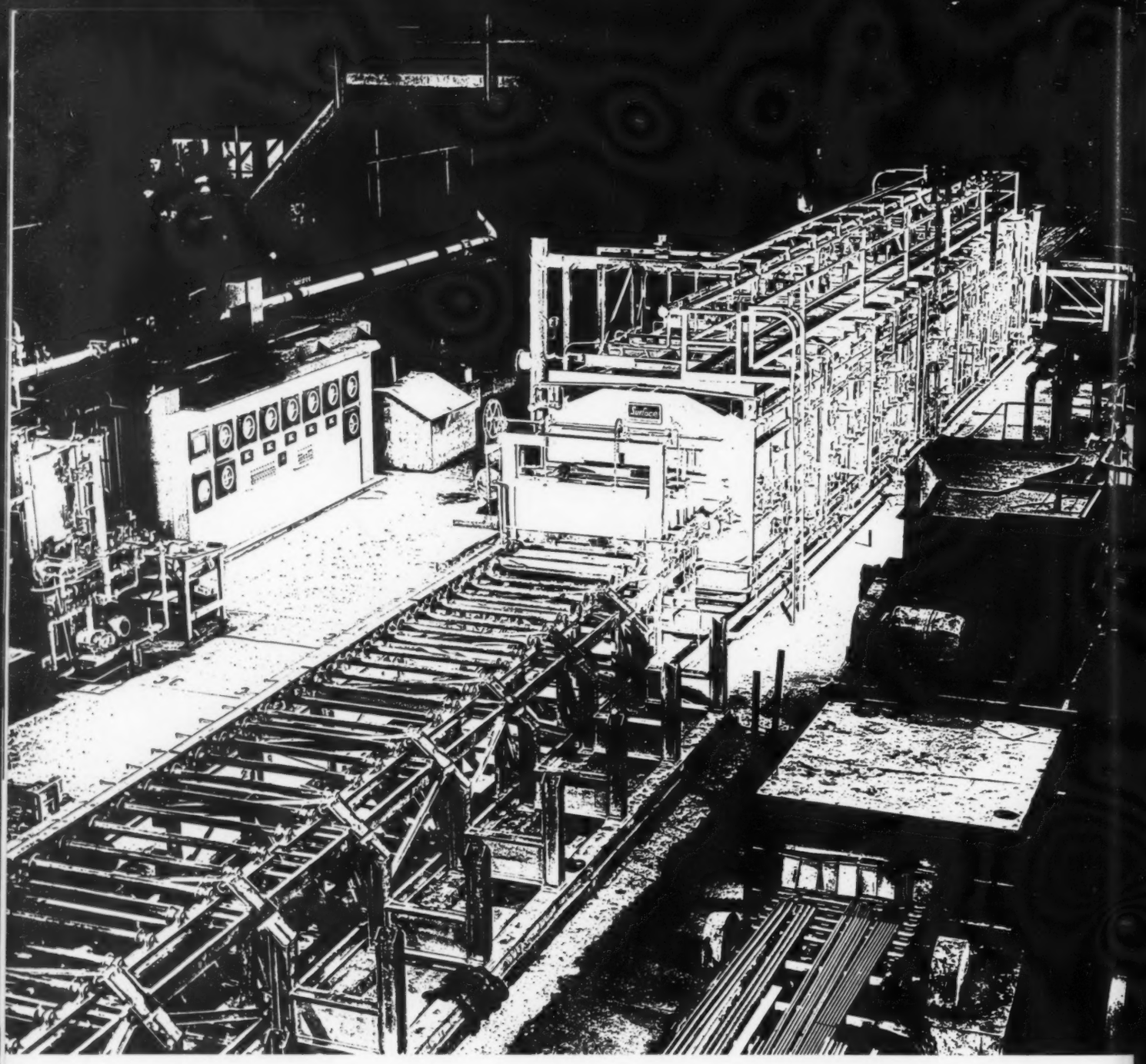
THE HALLDEN MACHINE COMPANY • THOMASTON, CONNECTICUT

Associates: The W. H. A. Robertson & Co., Ltd., Bedford, England



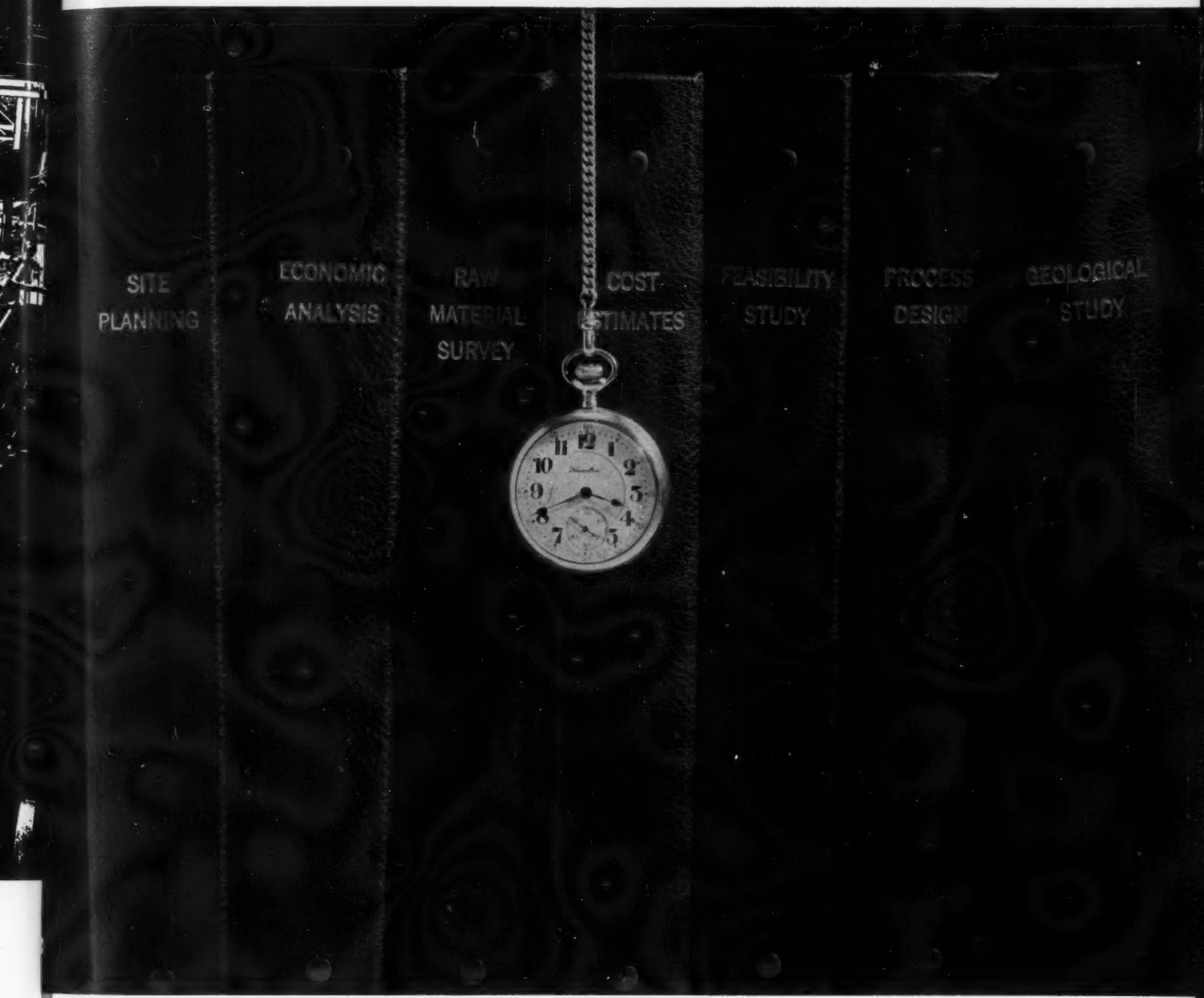
Courtesy of Jones & Laughlin Steel Corporation

Produces more steel and happier customers: Both Jones & Laughlin Steel Corporation and its customers have gained from this Surface furnace. For J&L, it affords continuous high production, uniformity through every bar in each load, accurate repeatability, and a variety of heating-cooling cycles. For J&L's customers, it delivers bar stock with the uniform microstructure which improves machining efficiency and profits. Address inquiries to 2404 Dorr St., Toledo 1, Ohio.

SURFACE

SURFACE COMBUSTION, Toledo 1, Ohio/ a division of Midland-Ross Corporation MR

Pre-Engineering by **KAISER ENGINEERS** answers basic plant expansion questions...



Timely? Many complex factors shape the final decision to proceed with your expansion plans...and timing is an important one. Independent analysis of all aspects of your proposed program is the *Pre-Engineering* service offered by Kaiser Engineers. The studies and evaluations furnished by KE Pre-Engineering represent only one phase of total KE services. Kaiser Engineers designs and builds for the Steel industry...offers skilled experience in all types of facilities from raw material plants to finishing mills. From Pre-Engineering through design and construction, Kaiser Engineers provides complete, one-company service and ingenuity based on years of experience.

KAISER ENGINEERS

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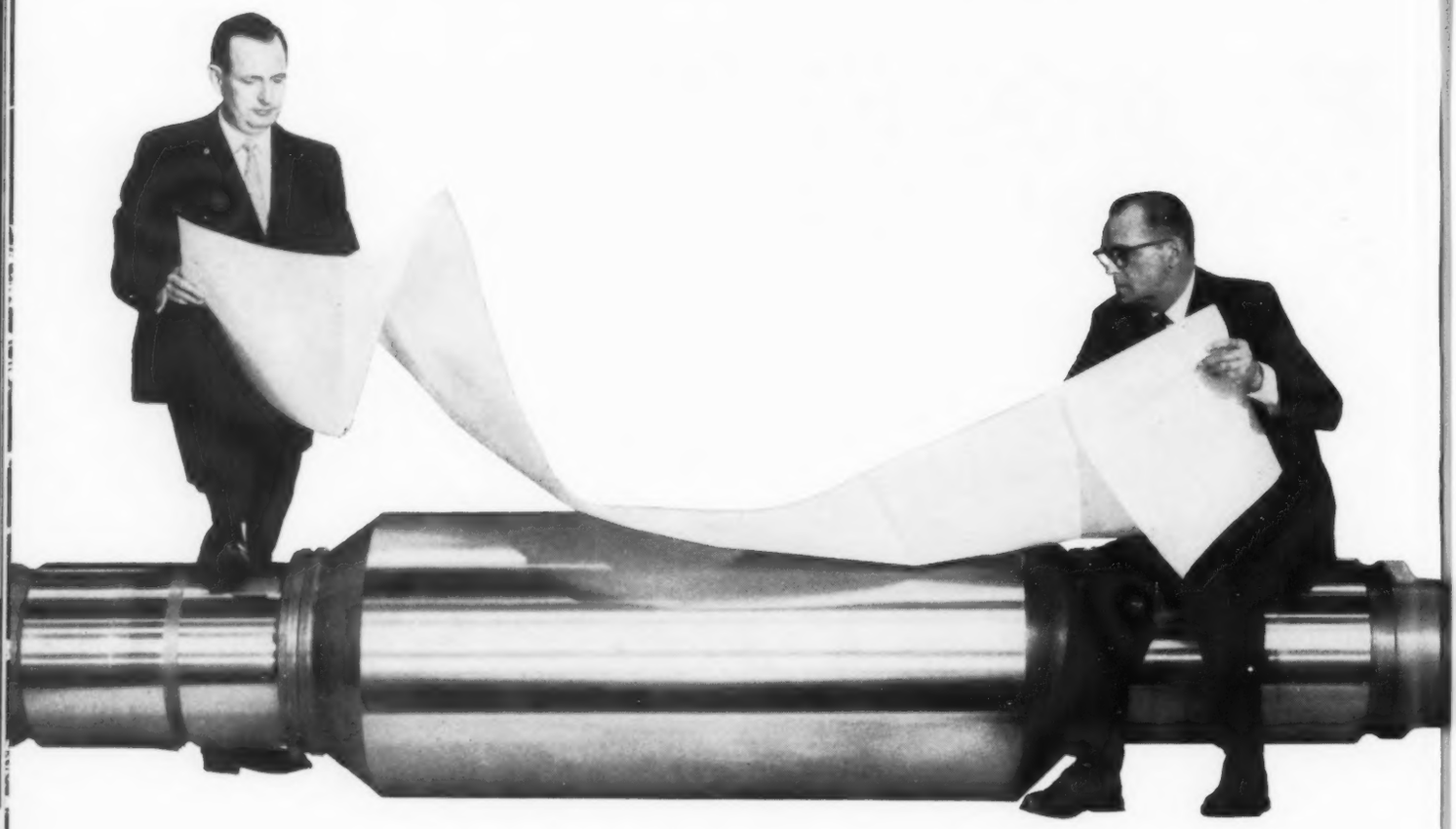
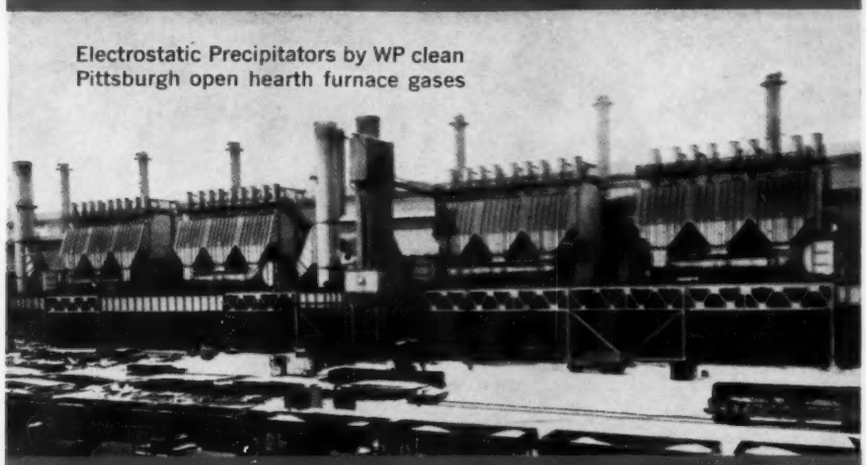


Analyzing history of roll use means future orders are better produced

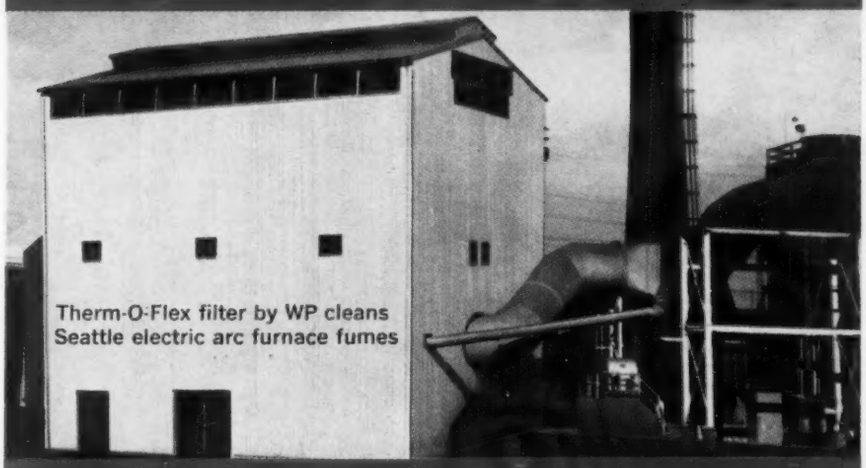
Through constant following of roll performance, National Roll keeps an accurate log of its rolls in hundreds of applications. These records are carefully analyzed by National's metallurgical and production staffs—discussed with customers by sales representatives such as "Easy" Esary and Bill Williamson, pictured above. Knowing about roll performance, National can make sure a roll order meets specific operating requirements and can assure higher quality with maximum roll service. Analysis of roll performance is just one of the customer benefits available at National, and is one of the reasons we say . . . NATIONAL'S THE GROWING NAME IN ROLLS.

NATIONAL ROLL & FOUNDRY DIVISION
GENERAL STEEL INDUSTRIES, INC., Avonmore, Pennsylvania
General Steel Industries, Inc., General Offices: Granite City, Ill. Plants: Granite City, Ill., Eddystone, Pa., Avonmore, Pa.
Subsidiary: St. Louis Car Company, St. Louis, Mo.



Electrostatic Precipitators by WP clean
Pittsburgh open hearth furnace gases

Open hearth steel in Pennsylvania... and electric arc in Washington...agree:



Therm-O-Flex filter by WP cleans
Seattle electric arc furnace fumes

When DUST is your problem— CLEAR IT WITH WP*

For an efficient, economical solution to any dust control problem—look to Western Precipitation. WP is uniquely fitted to handle your unique problem—being the one organization that custom designs, engineers and installs ALL types of dust and fume control equipment: Precipitator, Mechanical, Jet-Cleaned Filter, Hi-Temp Filter, scrubbers and engineered combinations.

With no axes to grind for any one system, WP engineers will give your job a completely unbiased recommendation—whether it's a quote on your specifications, a single component, or a completely engineered installation . . . small, major, simple, or complex.

An inquiry—on your business letterhead—will bring you literature promptly. Just write Western Precipitation, 1000 W. 9th St., Los Angeles 54, Calif. (In Canada, write 8285 Mountain Sights Ave., Montreal, P.Q.)

Dust and fume control since 1907

*WESTERN PRECIPITATION

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Division of Joy Manufacturing Company

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MULTICLONE Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX HI Temp Filters
TURBULAIRE Scrubbers
JOY-MICRODYNE Scrubbers
also: **HOLO-FLITE** Processors
HI-TURBIANT Heaters
TURBULEX Calciners

TRABON®

CENTRALIZED LUBRICATING SYSTEMS

Close-up shows Trabon feeders and lubricant lines protecting a quarry jaw crusher.

No bearing wear in 9 years of shock loads — abrasive dust

Jaw Crusher Bearings Stay Young and Healthy Protected by Trabon

"Downtime" is an unknown word at Millwood Sand's plant at Howard, Ohio. This happy state of affairs is due to a busy Allis-Chalmers Jaw Crusher installed in 1951 that has never had a bearing replacement or even a shim adjustment for wear take-up on the bearings. Reason is that bearings are protected by a Trabon automatic centralized grease system.

Imagine the savings that have accrued during these 9 years in:

1. Elimination of "downtime" with uninterrupted production
2. Elimination of bearing replacement costs and millwright labor
3. More efficient application of lubricant
4. Reduction of power costs and smoother operation
5. Elimination of hand lubrication man-hours.

If Trabon can perform so reliably under conditions of shock load, abrasive grit and dust for 9 years (incidentally, without replacement of a single Trabon part) —you can be sure it will provide the same dependable protection for *your* machine or plant.

Trabon oil and grease systems; *first with central warning in case of blockage;* first with a *positive* lubrication system—make sure that every bearing gets a positive, piston-displaced, measured shot of lubricant. No bearing gets skipped, forgotten or under-lubricated.

Whether your machine requires grease, oil, circulating oil or gear spray you can rely on Trabon. Call your local Trabon representative for help and advice.

"*Centralized*" OIL AND GREASE SYSTEMS "*Meterflo*" CIRCULATING OIL SYSTEMS "*Meter-Mist*" OIL SYSTEMS

Trabon® **Trabon Engineering Corporation** 28785 Aurora Road • Solon 39, Ohio

Equipment News...

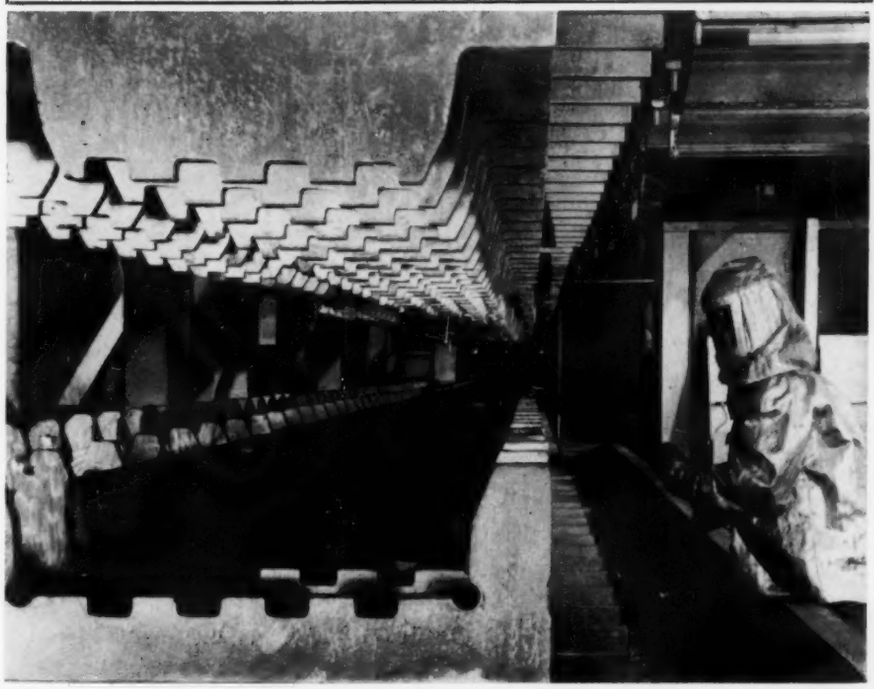
LIFT TRUCKS

△ The new electric model ELF and gas model GLF series of lift trucks, through five-ton capacity, manufactured by the Automatic Transportation Co., feature a drive axle that is a combination helical, bevel and spur gear assembly entirely enclosed and running in oil. All gears are accessible for removal without dismounting the axle from the frame. It is designed to operate for extended periods of time without any attention except for possible tire and brake servicing.

The trail axle and drive unit is equipped with tapered roller bearings and is interchangeable on both ELF and GLF models. The entire drive axle assembly is mounted to the frame by means of large thrubolts.

The wide angle steer trailing axle is of a new, simplified design which positions the kingpins inside the wheels and makes the assembly shock absorbing when running over obstructions. Transmission of road shocks to the steering wheel is practically eliminated.

QUENCHED AND TEMPERED ALLOY STEEL SHAPES



Water quenching of U. S. Steel Corp.'s new heat treated alloy steel structural shapes requires special fixtures that clamp the shapes firmly to prevent distortion during the rapid cooling cycle. Waffle-like pattern formed by the upper and lower fixtures segments permits full flow of water to uniformily quench all areas of the alloy steel channel shown here. The new quenched and tempered alloy steel shapes are said to promise "important weight and cost savings in structural applications ranging from submarines to skyscrapers."

D-C POWER UNITS

△ A new line of silicon d-c power supplies for virtually every industrial application requiring d-c power has been announced by General Electric Co.'s Low Voltage Switchgear Department.

Available in ratings from 0.75 to 75 kw, the new line is divided into three basic industrial rectifier groups consisting of general purpose units, essential service units and synchronous motor field excitation units.

The three basic units were developed within the line to provide industry with more versatile rectifier units to best suit specific application requirements.

The new line incorporates silicon cells to convert a-c power to direct current.

Since there are no moving parts to lubricate or replace, maintenance on the power supplies is virtually eliminated except for visual checks and occasional cleaning of internal assembly.

Light weight and vibration-free operation eliminates the necessity for special foundations.

The convection-cooled power supply units utilize current-limiting fuses to protect the silicon cells against faults on the load and source side of the equipment.

Operating efficiency of the rectifier units is nearly constant at 96 per cent from ¼ to full load for units rated 25 kw and higher, while below 25 kw, efficiency decreases gradually to approximately 95 per cent.

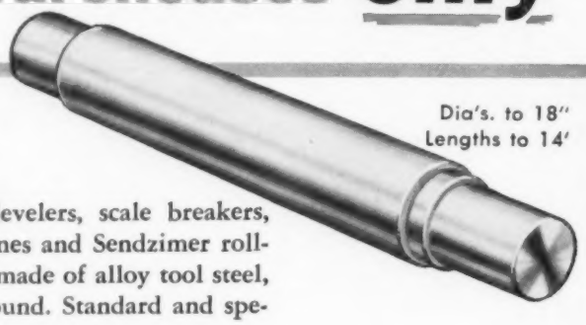
Available in both wall- and floor-mounted enclosures, the general purpose units feature a dynamic braking panel as an accessory item to safely dissipate regeneration caused by reversing actions of elevator or crane motors. These panels are available in ten ratings ranging from 1 to 20 kw.

A basic general purpose unit includes metal enclosure, transformer, surge suppression capacitors, silicon cells, cell-protecting current limiting fuses and pilot light. Standard units also incorporate an a-c contactor and an HCI switch fused for 100,000 I/C. An a-c breaker is included on 50- and 75-kw units only. Units above 5 kw include a d-c voltmeter and d-c ammeter.

Essential service units, with the same a-c and d-c ratings as the general purpose types, contain additional rectifier cells for greater reliability, a fuse monitor and d-c output fuses. Since all ratings of this type are above 5 kw, a d-c voltmeter and ammeter are standard components.

For STEEL MILLS

and warehouses *only*



Dia's. to 18"
Lengths to 14'

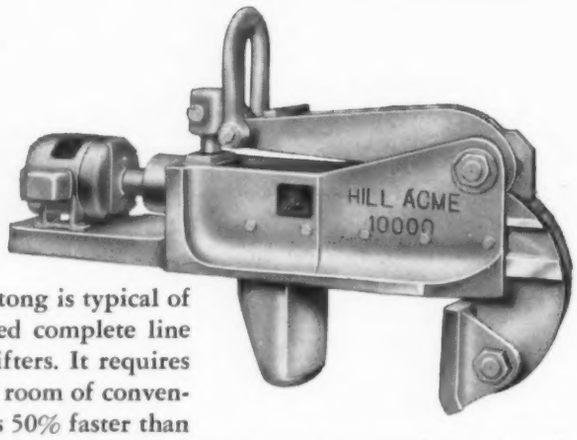
"HILL ACME" ROLLS

Custom made for levelers, scale breakers, straightening machines and Sendzimer rolling mills. Precision made of alloy tool steel, heat treated and ground. Standard and special types.

"CLEVELAND" METAL CUTTING KNIVES

The product of forty years of experience in manufacturing alloy grade, metal cutting knives of all types for shearing hot and cold metals.

"HILL ACME" MOTORIZED LIFTERS



This vertical coil tong is typical of the newly designed complete line of HILL ACME lifters. It requires only 1/3 the head room of conventional tongs and is 50% faster than mechanical types. Gives a constant grip ratio regardless of wall thickness and can be prepositioned to eliminate damage to the coil. Available up to 80,000 lbs. capacity. Contact us for "C" hooks, Rack Lifters, Billet, Sheet, Plate, Bar, Ingot and Ingot Mould Lifters.

THE HILL ACME COMPANY

1201 West 65th Street • Cleveland 2, Ohio

MANUFACTURERS OF: "HILL" Grinding and Polishing Machines • "ACME" Forging Machines • "CANTON" Rotary and Alligator Shears • BAR-BILLET Shears MATERIAL HANDLING Equipment • "CLEVELAND" Knives and Shear Blades.

The essential service units are designed to also incorporate the dynamic braking panel and are available in floor-mounted units.

Synchronous motor rectifier units are available in a-c ratings of 208, 230 or 460 volts, 3-phase, 60-cycle and in 125 or 250-volts d-c ratings.

A unique protective circuit connected to the rectifier output terminals fully protects the rectifier from reverse voltage surges.

Synchronous motor units are available in two designs; one for original equipment manufacturers for inclusion in control equipment; the other a standard unit for direct application with synchronous motors complete with control and protecting components.

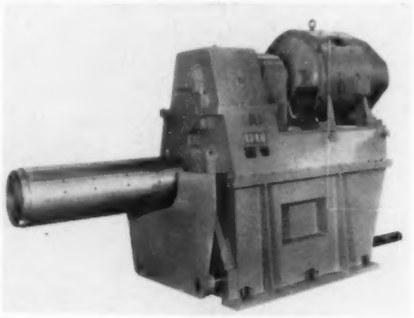
Original equipment (or basic) units consist of a metal enclosure, a transformer and panel with seven off-load taps, surge suppression capacitors, silicon cells, cell protective fuses, pilot light and field protective circuit.

In addition to components in the basic unit, the standard unit includes an a-c contactor and an HCI switch fused for 100,000 I/C. On units 5 kw and above, a d-c voltmeter and d-c ammeter are included.

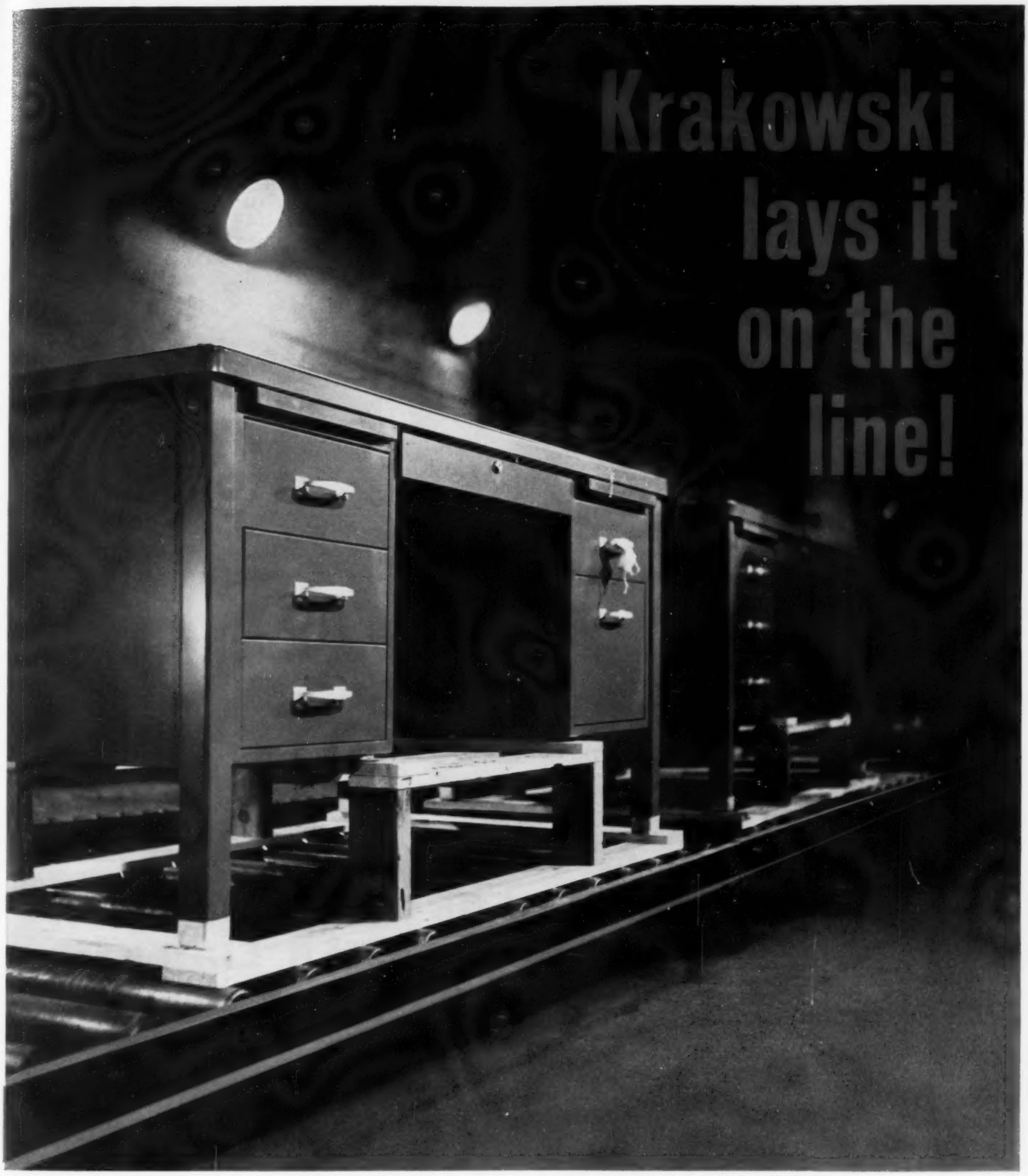
Units rated up to 4.5 kw, 125-volts d-c and 9 kw, 250-volts d-c are available in wall-mounted enclosures. From 6.5 kw, 125-volts d-c to 25 kw, 250-volts d-c, units are available in floor-mounted enclosures.

RECOILER

△ A new recoiler for slitting or coil-processing lines, announced by Steel Equipment Co., provides automatic speed adjustment to main-



tain constant strip speed required by the slitter or processing line. The variable-speed 100-hp d-c drive motor is regulated by a tachometer generator signal roll on the moving strip.



Lou Krakowski, General Superintendent of the Harrison Sheet Steel Company, is a guy who makes no bones about what he wants. It's service! And, for twenty years, he has been getting what he considers the best . . . Cities Service.

Turning out, among many other things, 125 steel desks a day, he wants complete and dependable lubrication service. One of the many Cities Service products he uses to get this job done is Trojan H-2 grease. For general greasing on all equipment, multi-purpose Trojan H grease has a wide range of application. And, because of the variety of jobs Trojan H grease does, it reduces his necessary lubrication stocks.

If you have to *get it on the line* . . . call your nearest Cities Service office . . . or write Cities Service Oil Company, 60 Wall Street, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

MIRROR FINISH FOR A PERFECT FOIL

Midvac Rolls

FORGED FOR EXTRA SERVICE MADE FOR BETTER FINISHES

Made from consumable electrode vacuum arc melted Midvac Steels with super uniformity of fine grain structure . . . maximum freedom from defects and non-metallic inclusions. Machined and ground to a black lustre, Micro-Lustre finish that assures rolling free of surface imperfections . . . quicker re-polishing . . . longer trouble-free service between grinds. These are the qualities of Midvac Rolls.

These vacuum melted finishing rolls are made to last longer and produce products unsurpassed in fine finishes. These rolls have cut repolishing time in half . . . lasted 33% to 50% longer on mill between grinds.

For a higher standard of quality and lower maintenance costs specify Midvac Rolls for your mill. Midvale-Heppenstall also makes forged steel rolls of any size, for any purpose required in the rolling of steel, aluminum, copper, bronze and other metals . . . as well as paper, plastics and rubber. Write for complete details to . . .

MIDVALE-HEPPENSTALL COMPANY • **NICETOWN, PHILADELPHIA, PA.**
SUBSIDIARY OF HEPPENSTALL COMPANY, PITTSBURGH, PA.

H MH *Midvac Rolls*

VACUUM AND CONSUMABLE ELECTRODE STEELS • BACK-UP ROLL SLEEVES • FORGED STEEL ROLLS • FORGINGS
RINGS • PRESSURE VESSELS • INDUSTRIAL KNIVES • DIE BLOCKS • MATERIALS HANDLING EQUIPMENT

The block is mounted on the output shaft of the gear reducer drive which is completely enclosed in a special housing. The output shaft rotates in antifriction bearings, spaced for maximum rigidity and stability. A separate motor-driven gear pump provides continuous forced feed lubrication to the gearing, assuring adequate lubrication. Output shaft is proportioned for the heavy overhung load of a 40,000-lb coil. Maximum coil width is 54 in.

A built-in, bottom-mounted hydraulic coil pusher removes the coils from the automatic hydraulic block. A suitable coil car with hydraulic lift (floor or pit mounted) is usually furnished by SECO for removal of recoiled strip.

LIFTING MAGNET

△ A new bipolar lifting magnet of unusual versatility for handling steel structural shapes is announced by The Ohio Electric Mfg. Co.

The new Model B-42 bipolar magnet features readily replaceable pole shoes for longer magnet life. Another feature is the ability of the magnet to lift random lengths and sizes of structurals which need not necessarily be carefully positioned or stacked.

Shapes which can be readily lifted include beams, channels, angles, Z-sections and sheet piling. The design of the pole shoes also enables the magnet to lift large pipe sections.

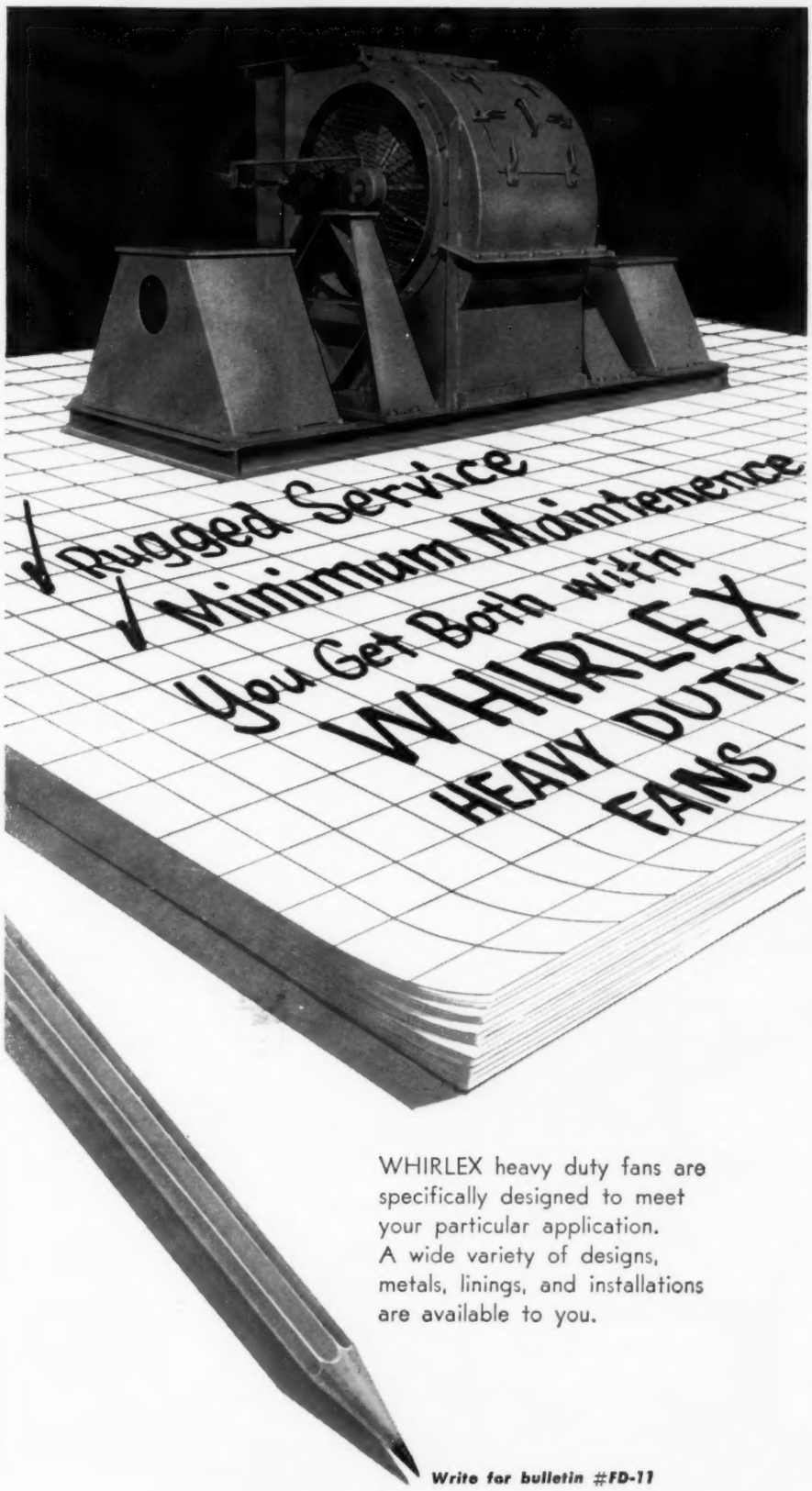
Lifting capacity of the standard B-42 bipolar lifting magnet is up to approximately 3000 lb, depending on several factors such as length of the beam, single or dual simultaneous pickup, etc. Weight of the unit, including chain-type suspension, is approximately 3100 lb.

Standard voltage is 230 VDC. All voltages are available on order.

ROTARY OFFSET PRINTER

△ Jas. H. Matthews & Co. announces a new marking unit designated Model L-6015 rotary "in-line" offset printer—for identifying pipe, tubing, bar stock and similar ferrous and nonferrous products.

Installed over a production line, the unit may be friction or power driven at any line speeds. It is of heavy duty construction for rugged industrial use. Trademarks, product



WHIRLEX heavy duty fans are specifically designed to meet your particular application. A wide variety of designs, metals, linings, and installations are available to you.

Write for bulletin #FD-11

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FLY ASH ARRESTOR CORPORATION

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Bag Collectors ■ Mechanical Collectors ■ Wet Collectors
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Now leading steel producer reports

ALEMITE OIL-MIST WITH THERMO-AIRE® CUTS HOT STRIP MILL LUBRICATION COST 90% ON WORK ROLL BEARINGS!

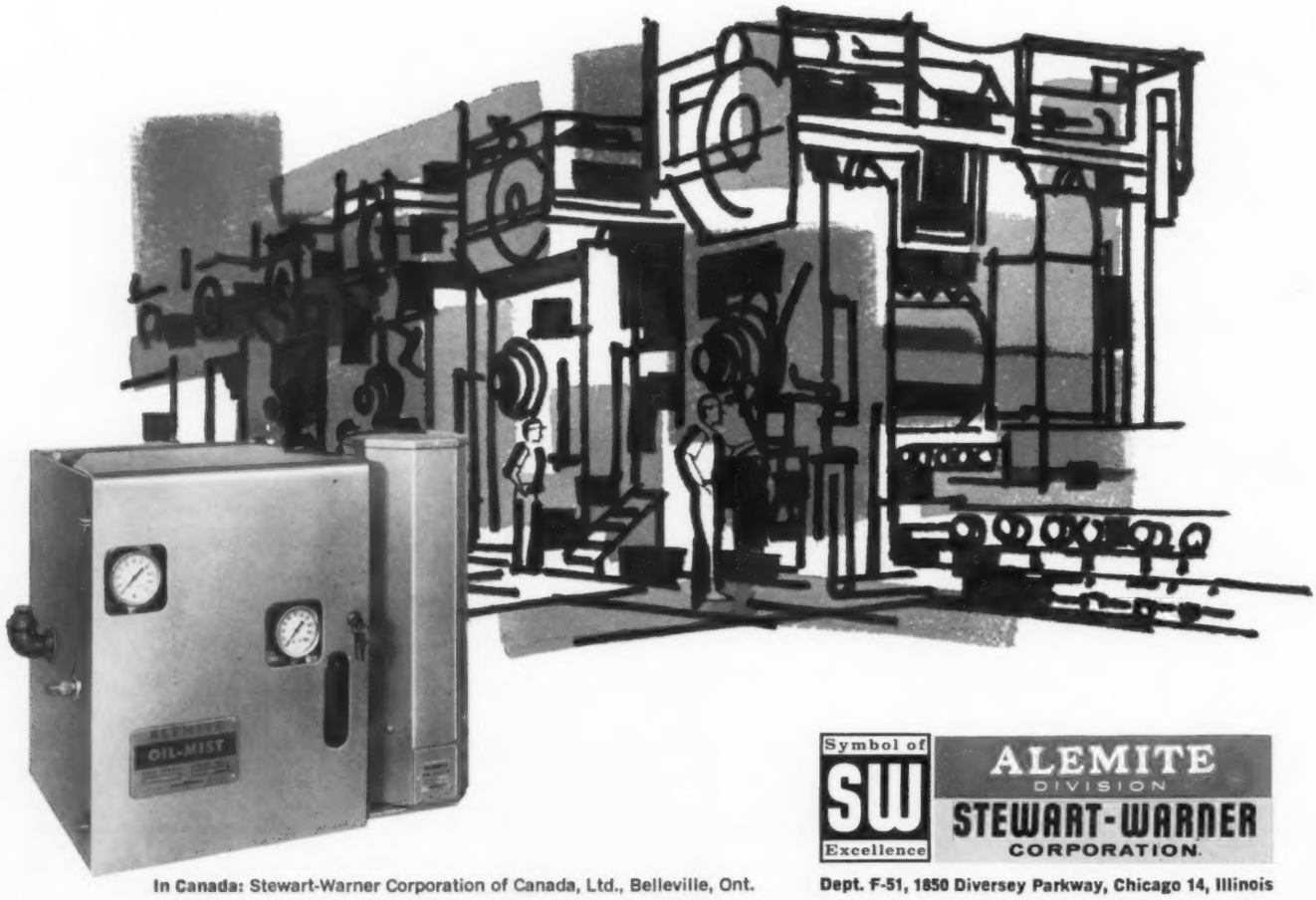
There is no comparison between Alemite Oil-Mist with Thermo-Aire and old-fashioned grease methods!

Take economy. Lubrication savings amount to $32.00 on every turn with Alemite Oil-Mist with Thermo-Aire. Oil-Mist was installed on one stand . . . and is being installed on nine other stands to replace an out-dated system for lubricating 40 roller bearings on an 80-inch hot strip mill. Working 15 turns a week, 52 weeks, these savings will add up to nearly $25,000 a year!

Take efficiency. Alemite Oil-Mist with Thermo-Aire is a fully automatic lubrication system. It applies lubricants constantly, properly, *without losing a minute of valuable production time.* It eliminates expensive packing of bearings with grease and also completely eliminates need to clean bearings of old grease. Its exclusive "Thermo-Aire" feature preheats incoming air—permits atomization of even the heaviest straight mineral oils to supply heavy-duty bearings with the high viscosity lubricants they need for smooth, steady performance.

Alemite Oil-Mist with Thermo-Aire will improve mill operating efficiency...lengthen bearing life . . . cut oil consumption and prevent product spoilage.

Write for illustrated brochure form 37-32, or see your Alemite representative for the amazing story of Alemite Oil-Mist with Thermo-Aire and how you can benefit from it!



Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

In Canada: Stewart-Warner Corporation of Canada, Ltd., Belleville, Ont.

Dept. F-51, 1850 Diversey Parkway, Chicago 14, Illinois

identification data or any other wording may be printed at desired intervals on lengths of pipe or other products.

The offset principle is employed in the printer as it enables the use of larger characters on smaller product diameters and causes no character distortion in the final printing.

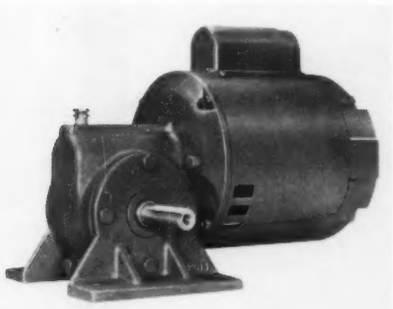
Products of any diameter, flat and most shapes, can be imprinted with the new offset printing unit. It is easy to install over existing production lines, and requires a space of approximately two ft x one ft for mounting.

GEARMOTOR

△ The Master Electric Division of Reliance Electric and Engineering Co. has introduced an entirely new line of fractional right angle gearmotors, 1/8 through 1/3 hp.

A significant change in the new line is weight reduction. The 1/4-hp gearmotor weighs only 26 lb. This is 20 lb lighter than the present unit.

An unusual feature of the new gearmotor is its reversible output

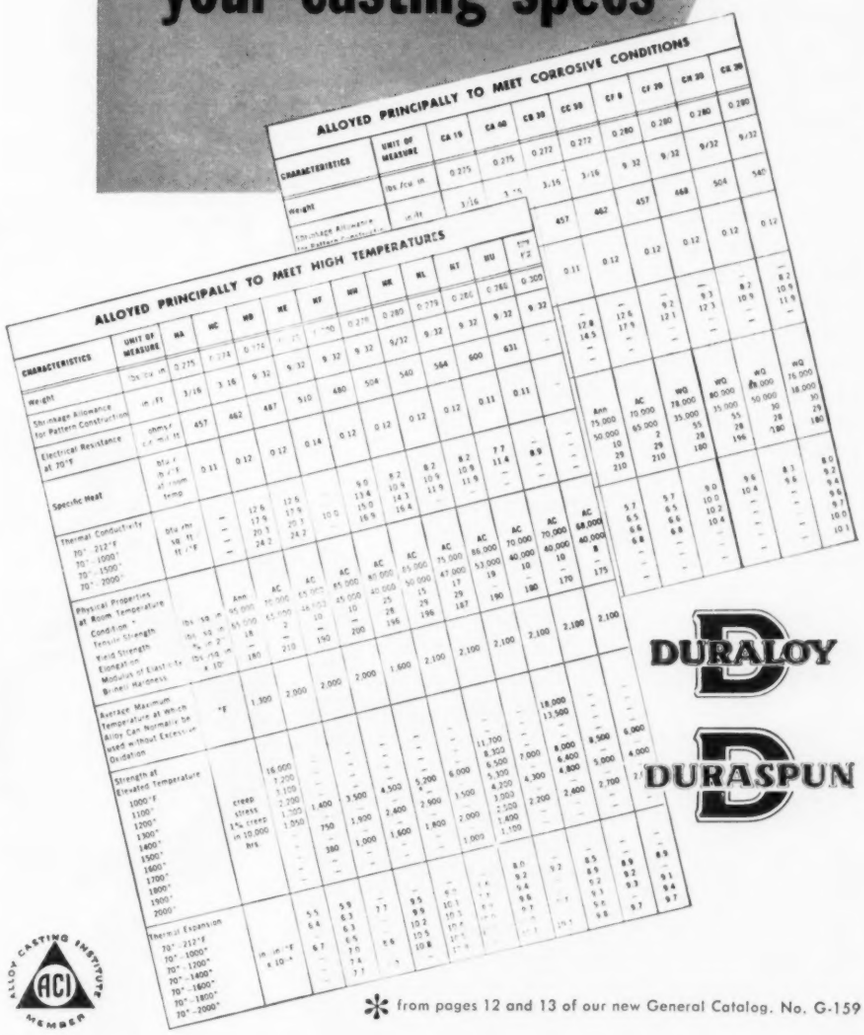


shaft. The user can transfer the shaft to the right or left-hand side of the gear unit in the field. The interchangeable bearing housing plates on either side of the gear head are easily removed. The shaft and reduction gear can then be taken out and inserted on the other side of the unit.

The new gearmotor is smaller over-all. The cast-iron gear case has an integrally cast end shield for mounting the footless "Duty Master" a-c motor. The mounting base for the gearmotor is located under the gear end, close to the power take-off, for maximum rigidity.

This new unit is available in 1/8, 1/6, 1/4 and 1/3-hp ratings in drip proof, totally-enclosed, and fan cooled enclosures. Thirteen reduction ratios are offered as standard.

* TABLES to help you select the proper alloy for your casting specs



* from pages 12 and 13 of our new General Catalog, No. G-159

— and there's lots more useful information about high alloy castings in our up-to-date catalog describing Duraloy Service. SEND FOR YOUR COPY.

As one of the pioneers in both static (1922) and centrifugal (1931) high alloy castings, we have a wealth of experience to focus on your high alloy casting problem. Send for our catalog, study it, and then let us help you get the best alloying combination to solve your corrosion, high temperature and/or abrasion problem.

DURALOY

DURASPUN

The DURALOY Company

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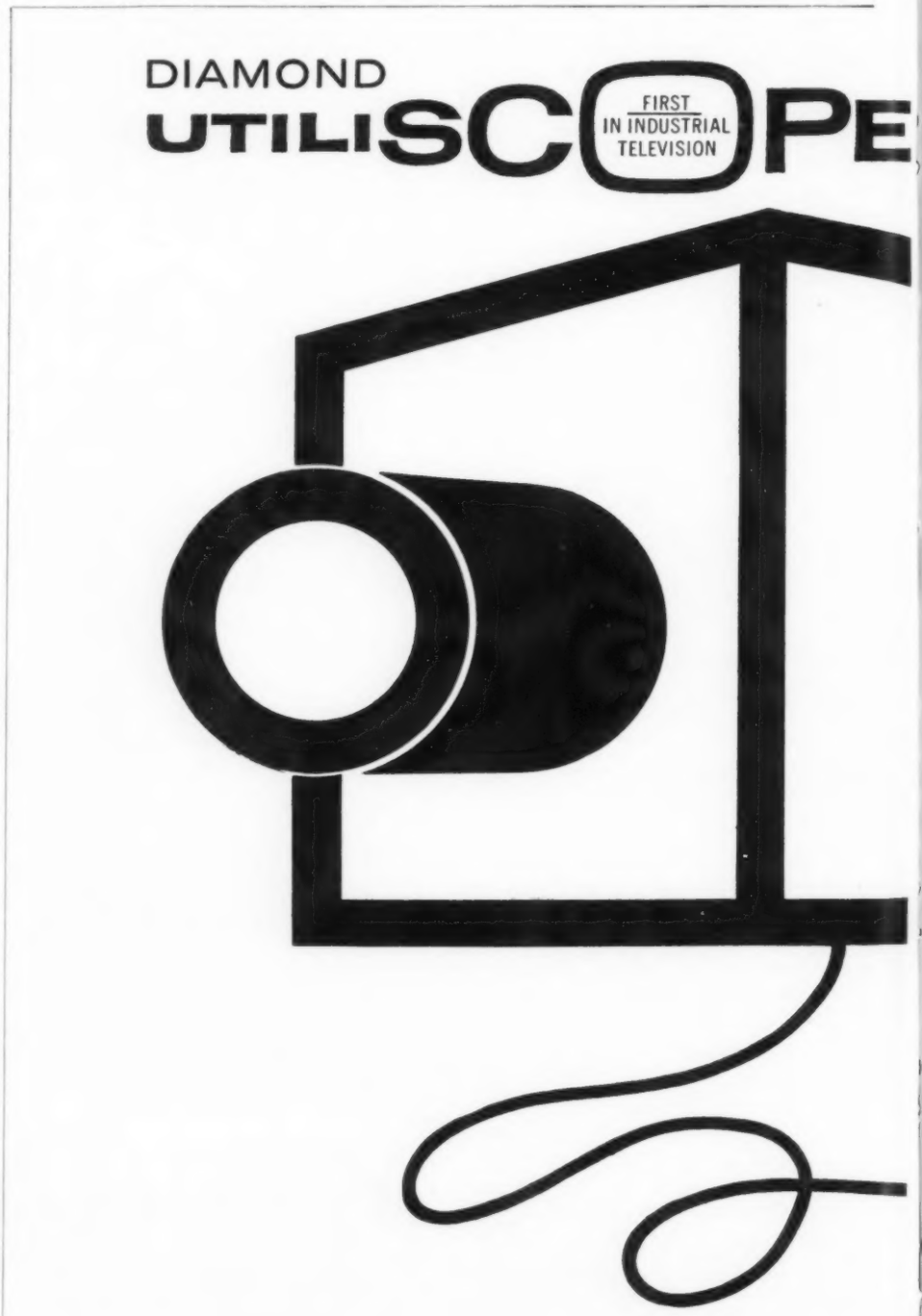
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23908 Woodward Avenue, Pleasant Ridge, Mich.

Book Reviews

"**Roll Pass Design,**" has been recently published by The United Steel Companies Limited and is obtainable from The Publication Department, P.O. Box 64, The Mount Broomhill, Sheffield 10, England. The book contains 280 pages, 6 x 9 in., is cloth bound, and sells for $9, U.S.A. or Canada (including package and posting), 3£ sterling, England. The object of this work is to set out the basic principles of roll pass design and to give an insight into the hot rolling process. A discussion of the characteristics of the hot rolling process and aspects of roll quality and strength precedes the systematical coverage of the design of passes by product groups. The chapters proceed from flat products to simple shapes such as squares, etc., to the more complex shapes including angles, rails, beams and channels. Where known and applicable, analytical methods of design, in each case, are given. In cases where the occurrence of variables such as roll temperature, roll material, roll wear, friction and product quality causes detailed analysis to be unnecessarily complex and unwieldy, accepted practice is quoted and discussed. Numerous illustrations, including photographs, tables, line drawings, charts, etc., are included to point up and explain the text.

"**Continuous Casting of Steel,**" by M. C. Boichenko has been published recently by Butterworth, Inc., 7235 Washington Ave., Washington 14, D.C. The book contains 216 pages, 5½ x 9 in., is cloth bound and sells for $9.50. This book contains a short survey of the present-day position of semi-continuous and continuous casting of nonferrous and ferrous metals and alloys, and discusses the metallurgical foundations of continuous casting. It gives a critical survey of the development of present-day methods of continuous casting of steel, both abroad and in the Soviet Union, and considers technical details regarding equipment. It contains also the technical parameters of continuous casting of steel and the results of comparative investigations of the quality of cast ingots produced by continuous casting and by the normal method of casting into ingot mold. Economic considerations and the future on continuous casting of steel are also examined. The book is very amply illustrated, employing photographs, line drawings, charts, tables, to complete and explain the text.

"**Engineering Management**" (second edition) by Struan A. Robertson has been published recently by Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. The book contains 467 pages, 5½ x 8½ in., is cloth bound and sells for $10.00. The book discusses the scope of the constructive "art" of management as applied to the establishment and conduct of an engineering manufacturing business, stressing the skill required in encouraging and maintaining a spirit of enterprise among the organization's members, and the discipline underlying this skill. It further discusses the "science" of management, and the scientific method of ascertaining and handling the innumerable facts and observations on which industrial agreements and relationships are based. The third phase describes the "practice" of management, and



illustrates the energy and drive required in planning, organizing and carrying out an engineering enterprise. Many references are listed and tables and charts are used to illustrate the text.

"Centrifugal Pumps: Selection, Operation, and Maintenance," by Igor Karassik and Roy Carter has been published recently by F. W. Dodge Corp., 119 West 40th St., New York 18, N. Y. The book contains 488 pages, 7⅛ x 10 in., is cloth bound, and sells for $15.75. This book, encyclopedic in scope, presents information covering the entire field of centrifugal pumps—their drives, controls and other appurtenances; and describes fully all types of pumps, including vertical, self-priming and regenerative. Specific pumps for every area of industrial and utility service are discussed. The information is given in a practical manner with theory introduced only where it is essential to the understanding of specific problems in planning, selecting, operating and maintaining systems. All parts of the pump unit are discussed: casings, impellers, shafts, stuffing boxes, seals, bearings, bedplates, controls, diffusers, wearing rings, shaft sleeves, balancing devices, injection seals, couplings, supports drivers. All materials of construction are analyzed for selection, performance and repair. There are 575 illustrations, including photographs, detailed drawings, schematics, layouts, tables, charts, diagrams and checklists, all of which were selected for clarity and practical use.

"Fundamental Principles of Powder Metallurgy," by W. D. Jones has been published recently by St. Martin's Press, Inc., 175 Fifth Avenue, New York 10, N. Y. The book contains 1032 pages, 5½ x 8½ in., is cloth bound, and sells for $30. This book discusses in great detail the techniques of powder metallurgy and explains the fundamental principles involved in them, and the book may well be used as a standard work on this subject. Many references are given, illustrations, including photographs, line drawings, tables, etc., are employed to supplement and explain the material.

"Techniques of Non-Destructive Testing," edited by C. A. Hogarth & J. Blitz, has been published recently by Butterworth, Inc., 7235 Wisconsin Ave., Washington 14, D. C. The book contains 209 pages, 5½ x 8½ in., is cloth bound, and sells for $7.50. This volume contains most of the material presented during the (1959) evening course of lectures on this subject given at Brunel College (Great Britain) plus additional work—all submitted by specialists in the particular subject. Most of the chapters are self-contained accounts of the theory and practice of electrical, magnetic, mechanical and visual testing techniques. Chapters dealing with ultrasonic, radiological and thermal comparator methods are supported by detailed introductions on their scientific backgrounds. Also, the manner in which many of the techniques are in use within British government establishments is outlined. Numerous references are cited, and illustrations, photographs, line drawings, charts, tables, etc., are used to supplement and explain the material.

"Design of Welded Structural Connections," by Omer W. Blodgett and Dr. John B. Scalzi, has

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been published recently by The James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio. The book contains 92 pages, 8½ x 11 in., is double wire bound with simulated leather cover, and sells for $1 in the U. S. and $1.50 elsewhere, postage paid. This new manual summarizes current practices and gives examples and problems of application. It does not discuss theory. The book covers arc welding process, the weldability of steels, distortion, erection and inspection. The design of connections for buildings and bridges using the elastic and plastic theories is covered. This discussion of connections includes classification, strength, and size of welds and procedures for welds. Plastic theory is presented giving load factors for welds, rules for connections, corner connections, and beam-to-column connections. Photographs showing typical welded structures are included in the 124 illustrations that are used to supplement and explain the text.

"The Electro-Erosion Machining of Metals," by A. L. Livshits, has been published recently by Butterworth Inc., 7235 Wisconsin Avenue, Washington 25, D. C. The book contains 126 pages, 5½ x 8½, is cloth bound, and sells for $5.75. A complete and up-to-date description of the state of technique, technology and industrial uses of electro-erosion machining is given in this book. Electrical machining methods and electro-erosion machining are described from the simple physical viewpoint, to establish general laws holding good for the various types of electro-erosion processes. The book is amply illustrated with photographs, diagrams, schematics to supplement and explain the text.

"Engineered Castings," by Glenn J. Cook, has been published recently by McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y. The book contains 240 pages, 6 x 9 in., is cloth bound, and sells for $8.50. The book emphasizes casting use, rather than casting production, and covers such topics as sand molding, shell molding, investment casting, die castings, inspection and testing, vacuum casting, materials, casting designs and tolerance and foundry selection. A number of special features are covered including comprehensive instructions for buying castings encompassing all modern metals and processes; unique marketing data are presented, representing the combined findings of large and small organizations. The profitable design techniques presented will help the reader save money; all recent technical advances are described in detail. Each chapter contains review questions, an extensive bibliography on specialized foundry topics and many helpful tables of physical properties, tolerances and specific do's and don'ts of casting design. Many photographs, tables, charts and line drawings are included to help tell how to use, make, design and buy engineered castings.

"Flow Meter Engineering Handbook" (third edition), compiled and edited by C. F. Cusick, has been published recently by Minneapolis-Honeywell Regulator Company, Brown Instrument Div., Philadelphia, Pa. The book contains 170 pages, 7½ x 10½ in., is cloth bound, and sells for $7.50. Order from: Brown Instruments Division, Mail Station 0280, Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa. The book contains separate chapters on steam, liquid and gas flow calculations, each with data necessary to calculate or check an orifice plate installation. Three solutions to a flow problem are outlined in each chapter; an approximation check; a nominal orifice bore calculation; and a precise orifice bore calculation. The book also deals with selection of primary flow elements and recommended locations and contains a chapter on co-efficients for orifice plates as well as a summary of equations, nomenclature and conversion factors. Superheated steam factors have been expanded to include gage pressures up to 3000 psi in high pressure steam flow calculations. Nomenclature used in the handbook is that approved by major instrument manufacturers and, where applicable, agrees with ASME and AGA fluid meter reports. Numerous schematic diagrams, graphs, charts, tables and other data supplement the text.

"Economics and American Industry," by Leonard W. Weiss, has been published recently by John Wiley & Sons, Inc., 440 Park Avenue, South, New York 16, N. Y. The book contains 548 pages, 6 x 9 in., is cloth bound, and sells for $7.50. The volume presents studies of seven important American industries, agriculture, textiles, aluminum, electric power, steel, automobiles and retailing. In each case, theory is illustrated and evaluated by examining the actual performance of the industry involved; thus the relationship between the concepts of economic analysis and observed industrial behavior is presented more clearly, and the impact of theoretical conclusions can be made forcefully. The survey supplies a new interpretation of structure and theory, and each study contains a description of the structure of the industry; a presentation and evaluation of some significant aspect of theory; a review of the performance of the industry in terms of output, capacity, prices, profits, etc.; and a discussion of some important segment of public policy pertinent to the industry. Collectively these studies comprise a complete survey of price theory and a summary of public policy toward business at an undergraduate level.

"Metals Handbook" (eighth edition), Volume One—Properties and Selections of Metals, has recently been published by the American Society for Metals, Novelty, Ohio. Of size 8¼ x 10⅞ in., this cloth-bound book is available from the ASM at $30.00, and contains considerably more numerical information, tables and illustrations on its 1300 pages than was contained in the 1948 edition.

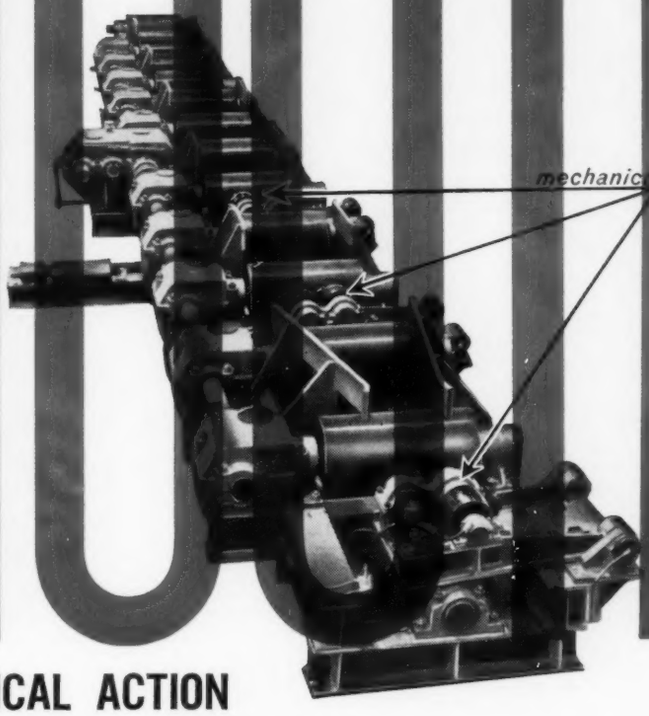
There are numerous sections which concern themselves with material selection with regard to specific engineering properties. Selection for maximum yield strength at minimum cost, hardenability, fatigue resistance, notch toughness, wear resistance and corrosion resistance of all commercial steel product forms are specifically covered in a 286-page section. Production practice and operating economics are also stressed. Stainless steels, special base alloys and nonferrous metals are discussed in detail, with data compilations covering 456 alloys.

This book probably has in one

(*Please turn to page 238*)

TREADWELL ENGINEERS

SMOOTH



EFFORTLESS MECHANICAL ACTION TO SPEED STRAIGHTENING OPERATION

The heart of this hydraulic straightener operation is Treadwell's roller table with its turning mechanism. Motor driven lift rollers, normally recessed under the table rollers, raise and rotate the round above the table, so that the operator can freely turn the round on its axis to determine easily whether further straightening is required.

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Mills, Rod
Mills, Vertical Edging
Mill Repeaters
Coilers & Reels
Tables, Mill
Tables, Tilting & Lift
Tables, Transfer
Transfers
Conveyors, Coil
Drivers & Pinions
Ejectors, Furnace
Gauges, Shear, Saw, etc.
Beds, Cooling
Beds, Inspection
Bumpers, Furnace
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a complete NEW family of Bulletin 709 Motor Starters

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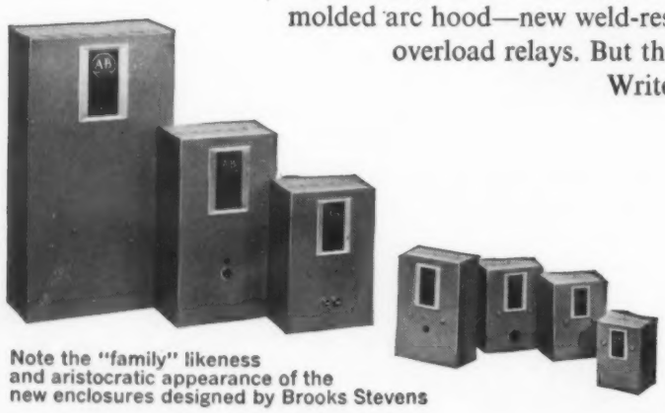
From their amazing compactness to their almost unbelievable operating life—measured in *millions* of operations—this entire family of Bulletin 709 solenoid starters is *new in every detail.* They feature a new, patented, high-efficiency magnet—new molded coil—new hot molded arc hood—new weld-resistant contacts—and new truly *trip-free* and *tamperproof* overload relays. But these new starters use the old Bulletin 709 heater elements. Write today for all the details on this really amazing new line of Allen-Bradley Bulletin 709 motor starters.



Note the "family" likeness and aristocratic appearance of the new enclosures designed by Brooks Stevens

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TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

Plain body rolls are a good buy for merchant mills

Ordering your roughing and intermediate stand rolls with plain bodies can save you money two ways – initially in the price of the roll, as a result of lower turning and molding charges and secondly, by reducing your roll inventory. When you cut your own passes, you have complete latitude in your use of the rolls, since you can "tailor" the rolls for your specific demands.

HARDNESS PENETRATION THE SECRET

Naturally, buying plain merchant mill rolls involves some care in choosing a suitable analysis: the rolls you order must have sufficient hardness penetration to provide for any of the pass depths you will need.

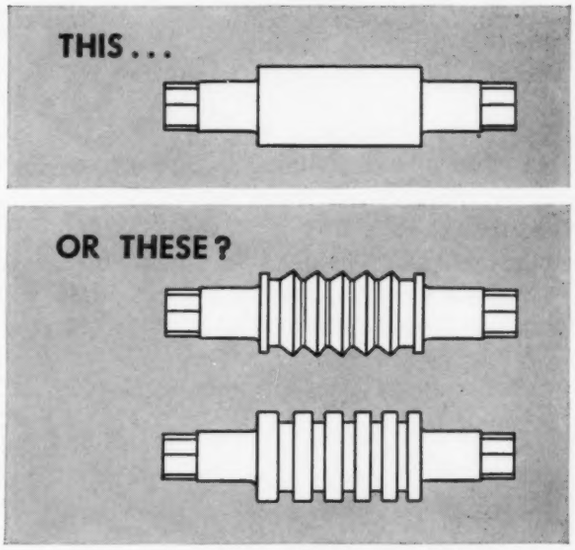
This is not as much a problem as it once was. Recent developments in roll metallurgy and heat treatment have made it possible to produce constant hardness from the surface to the center of the alloy steel rolls that we normally recommend for merchant mill service.

Thus, the only considerations are the severity of the service, and the hardness level that will provide the wear resistance the rolls need to serve any given campaign without requiring redressing.

The Mack-Hemp rolls that have proved themselves time and again in merchant mills are –

Technikrome–Formerly adamite, this is one of the most popular of all trade-named alloy steel rolls on the market. It is available in a wide range of carbon contents and heat treatments, with hardness from 36 to 52 Shore (C Scale).

Supermetal – Higher in alloy content, this roll possesses qualities common to cast steel in its strength and to cast iron in its wear resistance. Its fine, homogeneous structure makes it suitable for finishing rolls as well as roughing and intermediate stands. Available in hardnesses up to 55 Shore.



Stironite – An alloy steel in which the graphite occurs in unusually small particles, distributed uniformly throughout, thus possessing the finishing qualities of cast iron. These rolls are especially well suited for finishing. Available in hardnesses from 42 to 55.

All these roll analyses are stronger than the latest types of alloy cast iron, and, in the case of Supermetal and Stironite, as pointed out above, have many of cast iron's advantages as a material for mill rolls.

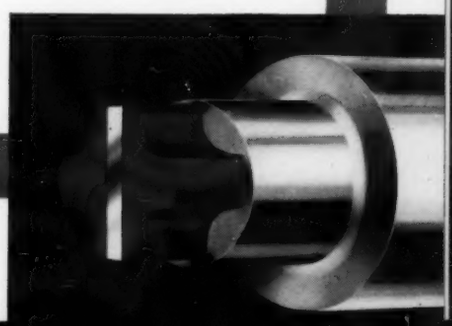
Whatever the type of mill you operate, you'll find that our trained roll engineers, backed by Mack-Hemp's 138 years of experience with mill rolls, can give you helpful advice on any rolling problem that's bothering you. Their assistance is yours for the asking. Simply write or telephone us at HEmlock 1-3000.

MACKINTOSH-HEMPHILL

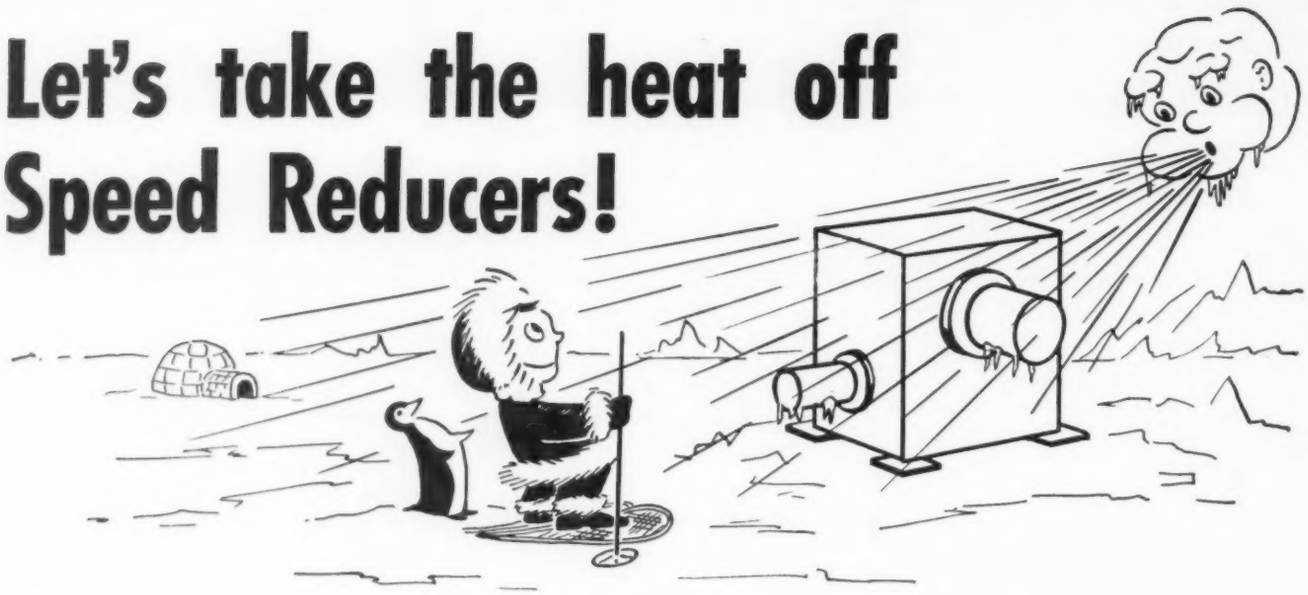
You get more tonnage from "the rolls with the Striped Red Wabblers"

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery



Let's take the heat off Speed Reducers!



A worm gear speed reducer is one of the toughest little customers in captivity. It reduces speeds day-in, day-out, with little complaint. While it works long and hard, it has limitations—set by ratio, center distance, RPM, mechanical and thermal HP ratings, etc. And, depending upon how precisely it was selected and fitted to the job requirements, it will do what it has to do.

But sometimes it's forced to play outside of its league. It must cope with job requirements that vary from here to there—normal 8 to 10 hour service without recurrent shock, the same length of service where there is some shock loading, continuous low-speed service and almost countless others. But the thing that really puts the pressure on reducers, the thing that's lurking in *every* set of job requirements—is h-e-a-t.

When you exceed the thermal capacity of a reducer for more than an hour or so, excessive temperature thins the lubricant resulting in wear; material, bearing and oil seal failures; etc. Of course, the proper lubricant will help but it can't cure the continuing problem of excessive heat.

So how can we lick this toughy? One way is to build the reducer housing oversize, big enough to radiate the heat away and keep temperatures down. But this type sticks out in aisles, louses up compact designs and barks shins. Then, we might try a smaller housing complete with fins on it to dissipate the heat. If this still doesn't work, another trick is to use a reducer with capacities and ratings a step above the ones we need. This is sending a man to do a boy's job. It's impractical, inefficient and costly. There *has* to be an easier, better, saner and cheaper way to do it. And there is!

In certain cases, where the size and type of reducer permits and where we can gain enough in thermal HP rating to keep heat generation in bounds, Cone-Drive Gears does it with fan-cooling.

What's that? Simple. Just add a fan to the worm shaft plus the necessary air shields, fan cover, etc., and presto!—heat is no longer a problem. The air shields direct the fan-pushed air over the fins on the lower portion of the reducer. The fins are shaped and spotted to guide the air stream where it is needed. Thermal HP ratings are boosted tremendously, as high as 147% above those of standard reducers in some cases! Those over-worked, over-heated reducers will now do the job you bought them to do.

Other advantages? They're here in abundance. The size of the reducer stays the same. All parts on a Cone-Drive fan-cooled reducer are 100% interchangeable with parts for standard reducers. Oil capacity is identical. Shields are quickly removed without disconnecting the reducer. (This is important where severe operating conditions make periodic cleaning necessary). The reducer can also be operated *without* fan-cooling just by taking off the fan and shields.

This simple addition to standard Cone-Drive HU speed reducers might be just your answer—might save you some money. Write for Cone-Drive's Bulletin CD-218. It will tell you all about the full line of Cone-Drive double-enveloping worm gear reducers as well as the fan-cooled kind. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

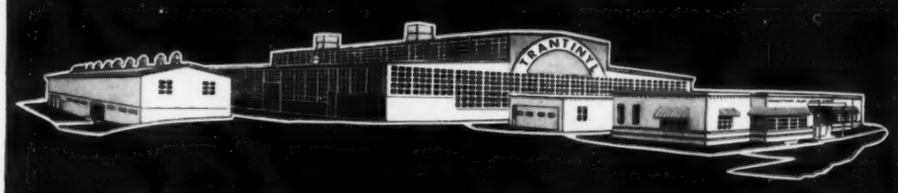
TRANTINYL GUIDES THE STEEL INDUSTRY

U. S. Steel Gary Works rolled 100,000 TONS with this pair of "TRANTINYL" GUIDES

These entry guides on finishing stand, 14" mill, were photographed after rolling 100,000 tons of rounds. Guides were still in serviceable condition.

14" Mill, Gary Works, with "TRANTINYL" Guides and Guide Box

"Trantinyl" Guides and Rollers hold exceptionally high tonnage performance records, in serving leading steel mills for a quarter-century.



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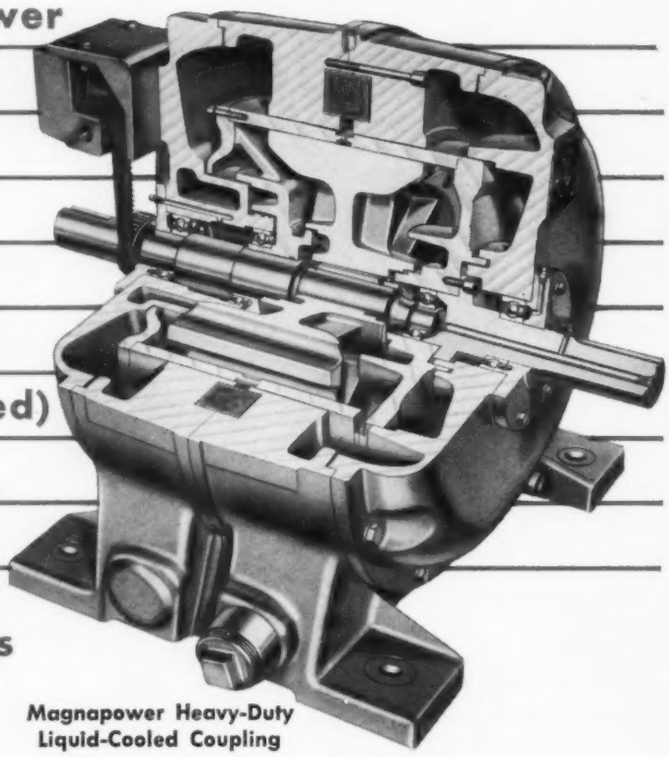

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Using standard alternating current as a power source, Dynamatic Eddy-Current Couplings and Drives are the answer to practically all stepless adjustable speed requirements.

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Dynamatic Eddy-Current Equipment is available in sizes from ¼ hp Ajusto-Spede Drives to heavy-duty Magnapower Couplings rated up to 20,000 hp—and larger.

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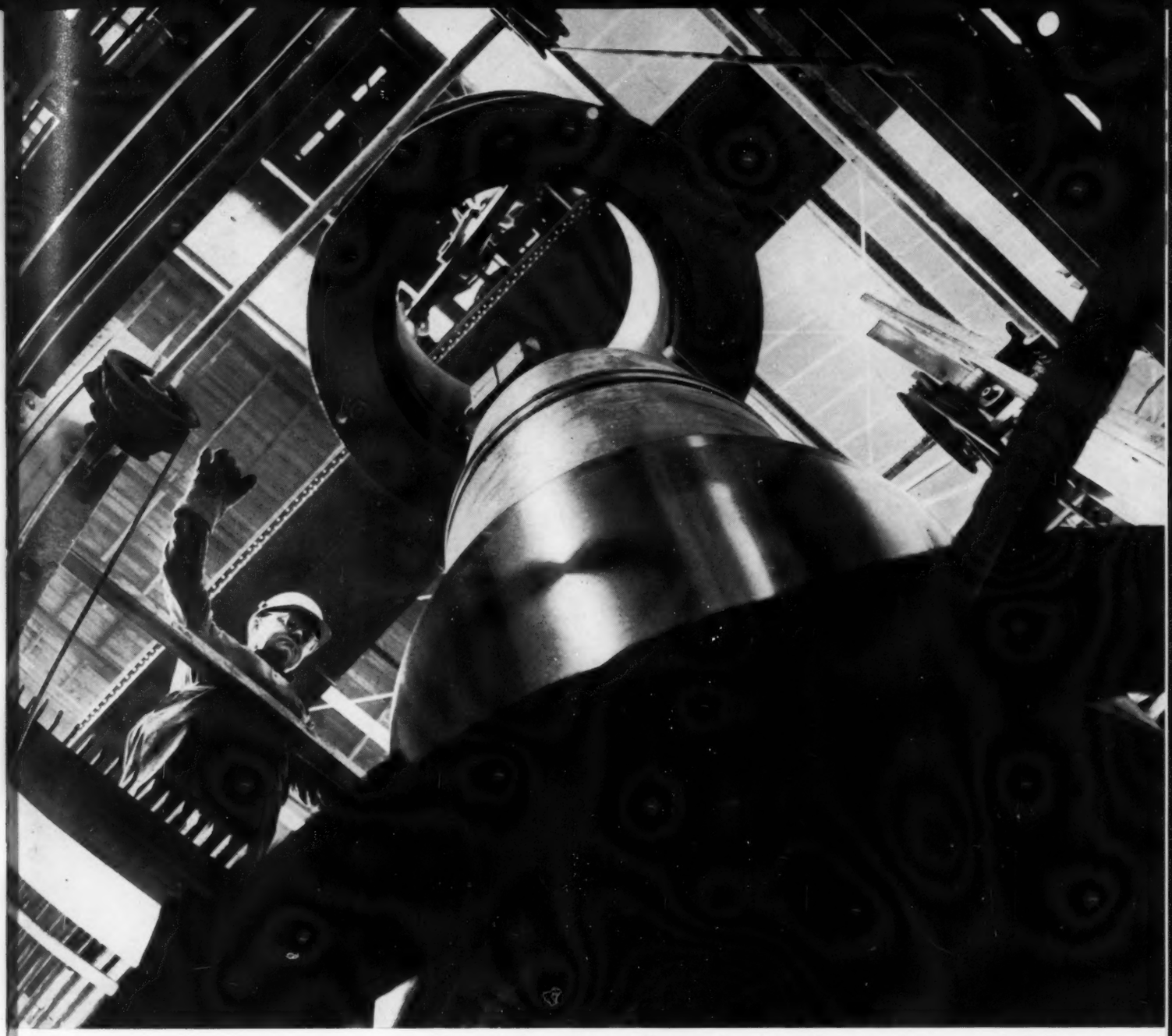

This forged alloy-steel sleeve is first heated to about 800 deg in order to expand its ID. Then it is lowered onto arbor, as shown. When the sleeve cools and contracts, it bites into arbor forming a tight fit.

Get more tonnage from back-up roll sleeves . . . make sure they're forged alloy steel

Our records show that a Bethlehem forged back-up roll sleeve on a modern continuous four-stand cold mill produces an average of 1,981,083 tons of cold-rolled sheets. Some have produced over 3 million tons! (And some of those are still going strong.)

Why this clear superiority over cast steel back-up rolls? Forged sleeves are denser and stronger. They offer greater resistance to spalling. You don't have to grind forged sleeves as frequently as you do cast steel back-up rolls, so you have much less downtime for roll changes. And you don't have to grind as deeply, so the sleeves last much longer. Result: more tonnage produced.

Bethlehem is well equipped to produce new sleeve and arbor assemblies; to replace used sleeves with new ones; and to install new sleeves on used back-up rolls. If you would like more information, get in touch with our nearest sales office. Or write to us at Bethlehem, Pa.

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added to EF Research Laboratory

This vertical furnace, newly installed in our research laboratory, will bright anneal 1500 lbs. per hour of 24″ wide strip at temperatures up to 2100°F. The strip is heated electrically in a hydrogen, dissociated ammonia or other protective atmosphere; is jet cooled prior to discharge; and does not come in contact with rolls in either the heating or initial cooling zones.

This furnace has already made successful production size experimental runs on various analyses of stainless steel trim stock for five large primary steel producers, and is expected to be used for research work on all grades of stainless, also carbon steel and non-ferrous strip.

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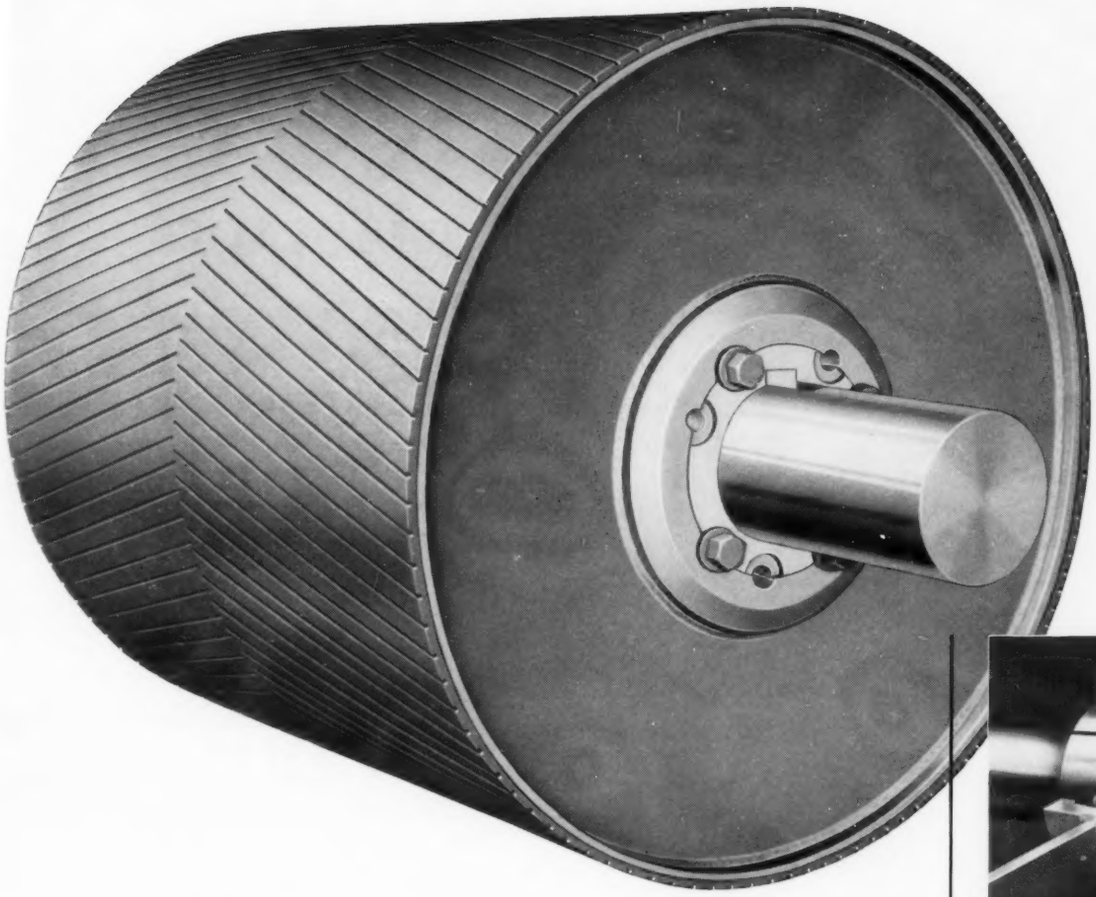
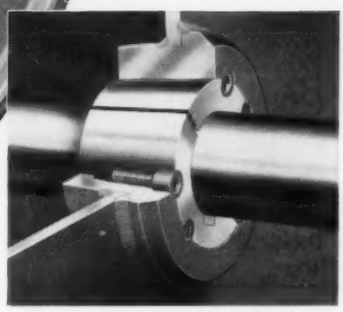
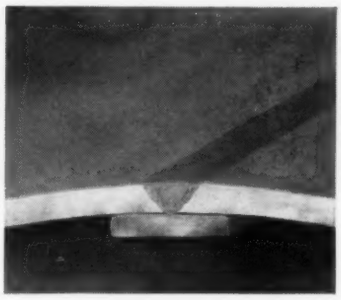
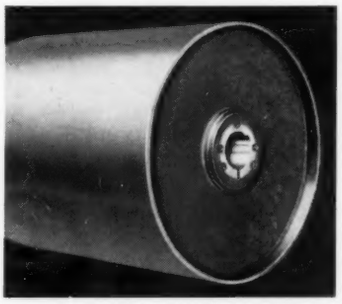




No "walking" on the shaft with Taper-Lock. Full length contact of hub. Holds under heavy loads and shock. Easy on — easy off.



Patented Back-up Bars give full rim strength through 100% weld penetration. Diametrically opposed bars insure balance.



Jointless construction creates a drum fully sealed against conveyed materials of all kinds as well as dirt, water and steam.

AMERICA'S NO. 1 STEEL CONVEYOR PULLEY!

There are more Taper-Lock Steel Conveyor Pulleys than any other operating on big jobs. Why? Simply because of the dependable performance they deliver under the toughest conditions.

The rims, discs and hubs are *steel* — and they are fused together into jointless drum construction for (1) maximum strength with minimum weight, (2) exclusion of dirt, water and steam, (3) terrific shock resistance. Every weld is made by the submerged arc process giving deep penetration and exceptional strength. Rims are accurately die formed in the smaller diameters and rolled in the larger diameters. Pulleys with 26″ and wider faces have interior discs that add to the trueness, rigidity and strength of the rims.

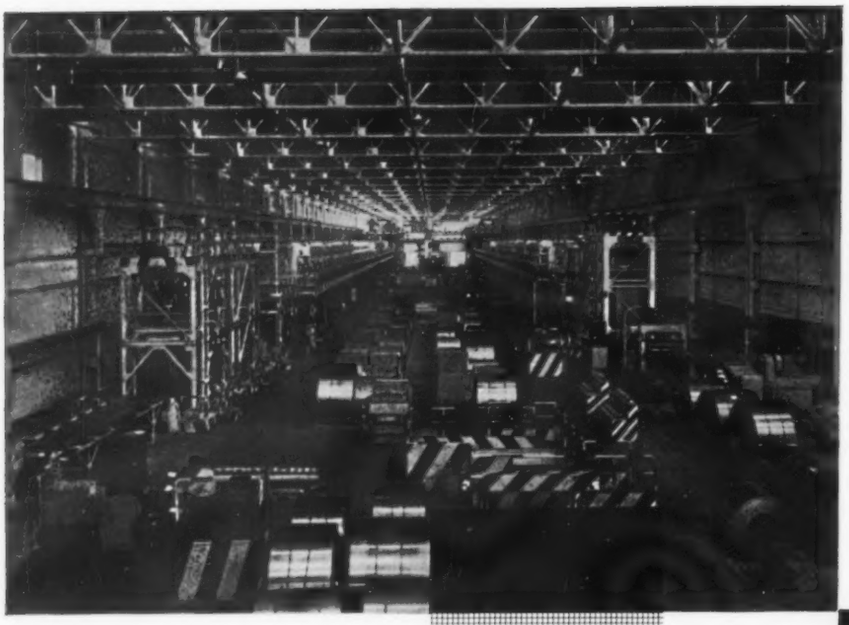
Dodge offers the world's biggest range of stock sizes. Diameters from 6 inches to 8 feet — all face widths, crowned or flat. Standard or special rubber lagging available. Ask your local Dodge Distributor — or write us for a technical bulletin.

Dodge Manufacturing Corporation, 5900 Union Street, Mishawaka, Indiana

The Products with the Pluses... **DODGE**

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Look under "Dodge Transmissioneer" in the white pages of your phone book. Factory trained by Dodge, he can give you valuable assistance on new cost-saving methods.



FURNACES AND HEATING EQUIPMENT

General view of two galvanizing lines constructed for S.A. Phenix Works at Flemalle-Haute (Belgium).

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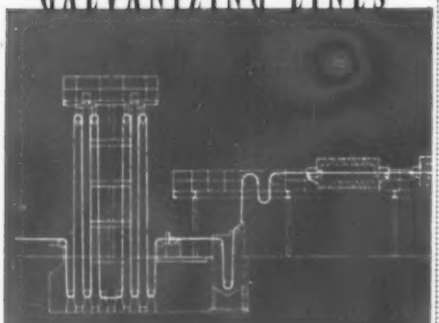

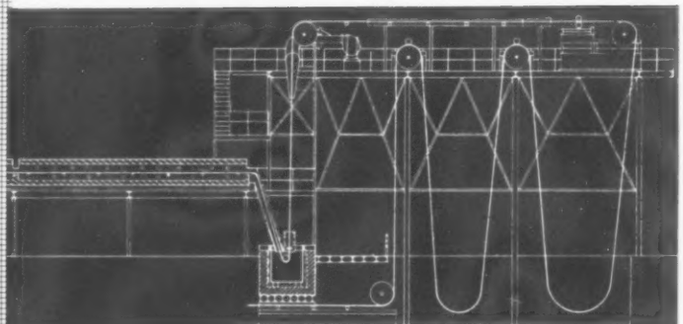

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(Continued from page 226)

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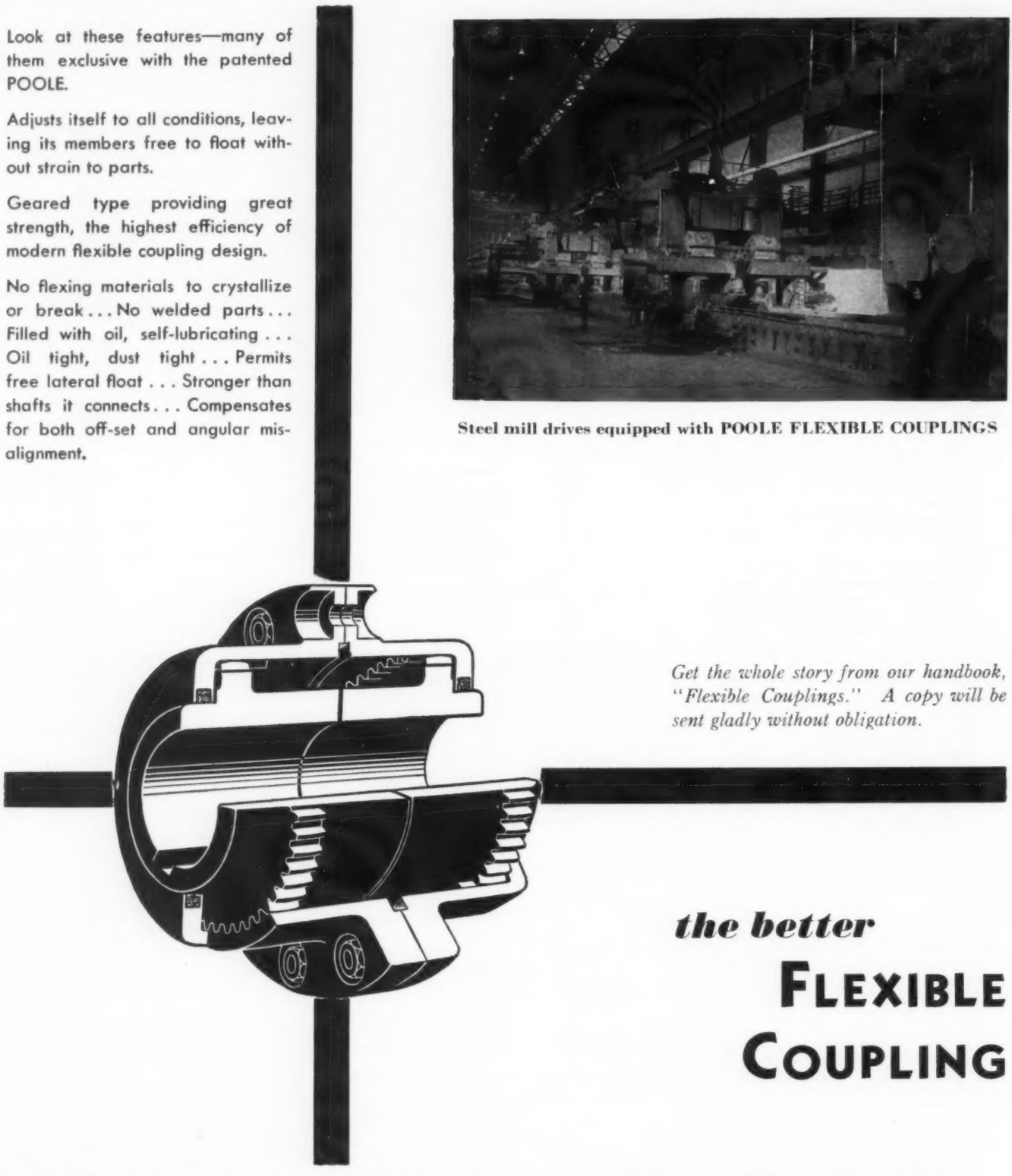

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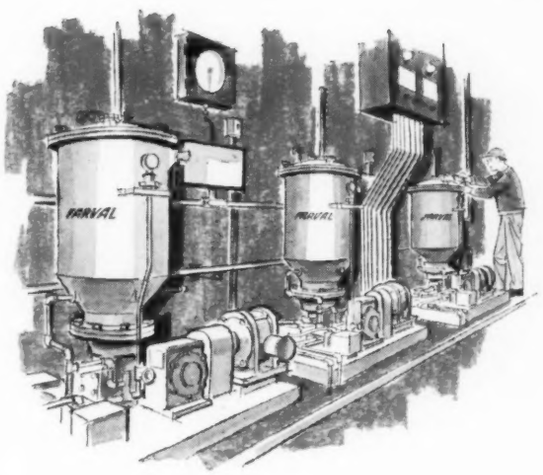

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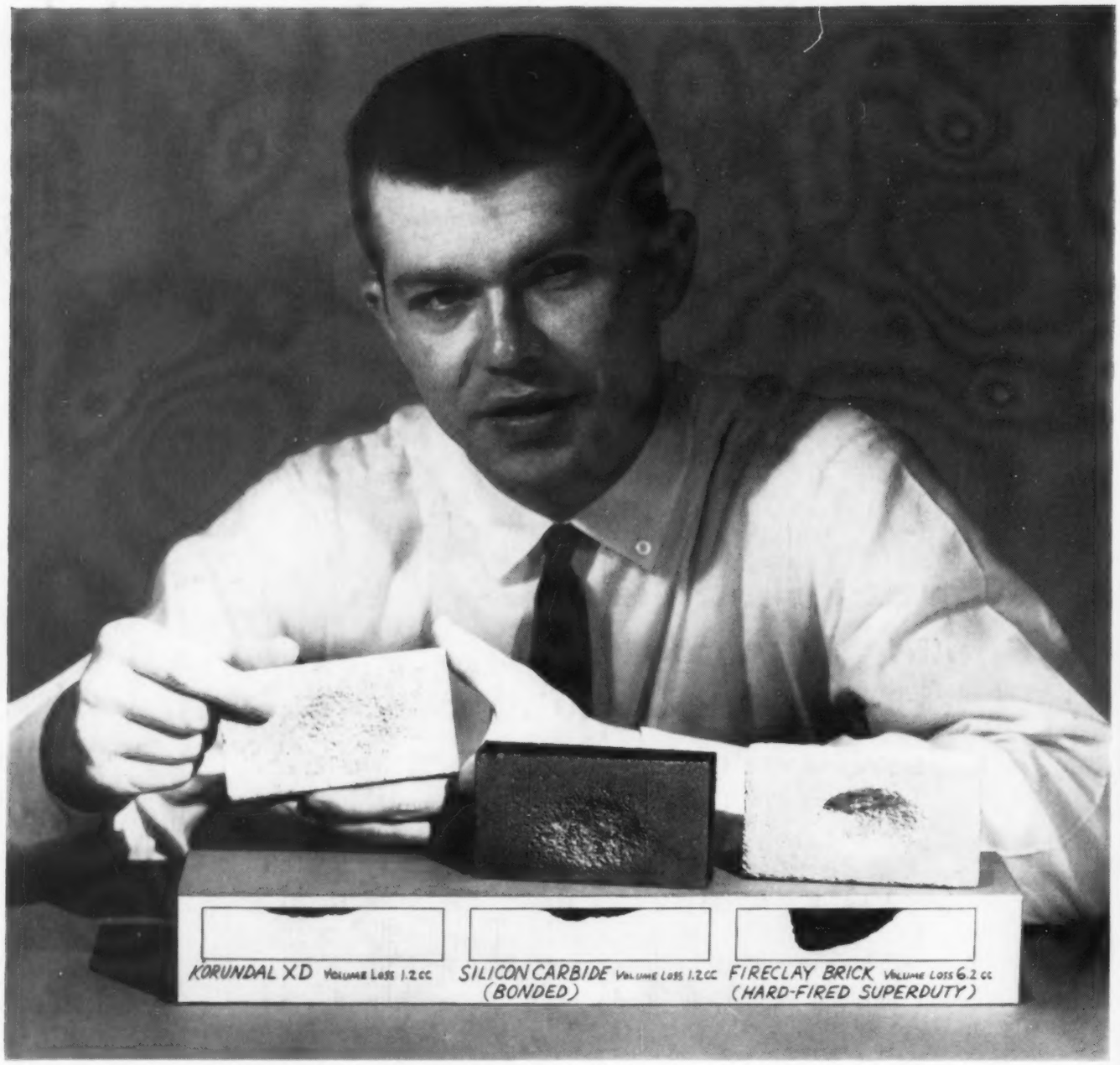
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